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TO ADVERTISERS

CHANGES for advertisements should be in this office by Friday noon for the following week's issue.
NEW ADVERTISEMENTS should be in the office not later than Monday noon to insure publication in that week's issue.

The traction railway situation in Boston has furnished to Dr. Louis Bell a congenial theme, and elsewhere in this issue will be found a vigorous criticism by him of the present elevated railroad system. Aside from the inevitable reflection upon the judgment of those responsible for the situation in Boston, the fact that such a railway was built and that such a criticism as Dr. Bell's may be made goes to prove that there is little enlightenment abroad on the question of railway operation. Now that electricians are going into the railway field it is time for some one to come forward with a thorough and sensible treatise on railway operation and location, laying down the fundamental principles of this science—for it is, or ought to be, a science—with the same care that has distinguished text-books in other branches of engineering. If Boston is so badly off as we are led to believe, let us benefit by the horrible example and try to do better next time.

INDUSTRIAL ELECTROCHEMISTRY.

It is with great pleasure that the ELECTRICAL REVIEW announces the early appearance of a series of five articles by Mr. J. B. C. Kershaw, of London, the well-known authority on chemical and electrochemical matters. The title of these articles will be "Industrial Electrochemistry," and they will take up, in a regular order, the applications of this branch of technology in the United States, the United Kingdom, France, Germany and the remaining countries of Europe. The articles will be illustrated and will form a compendium of the present state of the art.

The fine series of papers by Professor H. C. Jones, which has been appearing for some time under the title of "Selected Chapters in Electrochemistry," will be concluded in the next issue of the ELECTRICAL REVIEW. It is proposed then to begin the publication of Mr. Kershaw's articles, which will take up the subject of electrochemistry from the practical and engineering side, thus supplementing and continuing the series on this important subject, which Dr. Jones has so ably begun.

It was felt, in the selection of these papers, that the subject of electrochemistry is destined to become one of the most important in the whole range of electrical engineering, and that so far it has not received from engineers and electricians in this country a sufficient share of the attention which its great future importance merits. We have been accustomed to consider electrical application principally from the direction of motive power and lighting, forgetting, for the most part, that a very wide field is open in the utilization of the chemical properties and manifestations of electricity. It is hoped that these valuable and interesting papers will accomplish something for the enlightenment of the profession in this country regarding what has been going on and the present state of both the science and the art of electrochemistry, and it is greatly to be hoped that this subject, so full of the deepest interest and containing so many possibilities of high importance, will attract the more general attention of students, experimentalists and engineers.

THE ULTIMATE CONSTITUTION OF MATTER.

The charge that this age is superficial and hurried, that men are too much engrossed with the ordinary affairs of life to look deeply into anything is frequently made. This charge does not certainly apply to the scientific men of our age. Never was there a time in the history of the world when such large numbers of men were totally engrossed in their professions as at present. Nowhere is this fact better illustrated than in the case of the greatest scientific men of the age who are trying to ascertain what is the real constitution of matter.

For many years the conceptions which have dominated physical as distinct from biological science have been the theories of the existence of atoms; of the mechanical nature of heat, and of the existence of the ether. At the present time, the increasing knowledge of electricity is contributing vastly to change the conception of all of them. The generally accepted idea of magnetism in an iron bar as regards its molecules and the behavior of the iron under special conditions have taught us much concerning the molecular constitution of bodies.

Molecules of nearly every substance known have long since been resolved into their elements which are as real as anything known to man, but the minds of scientific men are not content to stop here. They must know more about the ultimate constitution of the elements themselves.

There is very strong reason to believe that something like the subdivision of the elements has been accomplished by Professor J. J. Thomson and Mr. C. T. R.

Wilson. No better idea of what are the conceptions of the greatest scientists at the present time concerning what has been done can be obtained than that expressed by Professor A. W. Rücker in his presidential address before the British Association for the Advancement of Science, which is as follows:

It is known that it is comparatively difficult to produce a fog in damp air if the mixture consists of air and water-vapor alone. The presence of particles of very fine dust facilitates the process. It is evident that the vapor condenses on the dust particles and that a nucleus of some kind is necessary on which each drop may form. But electrified particles also act as nuclei; for if a highly charged body from which electricity is escaping be placed near a steam jet, the steam condenses; and a cloud is also formed in dust-free air more easily than would otherwise be the case if electricity is discharged into it.

Again, according to accepted theory, when a current of electricity flows through a gas some of the atoms are divided into parts which carry positive and negative charges as they move in opposite directions, and unless this breaking up occurs, a gas does not conduct electricity. But a gas can be made a conductor merely by allowing the Rœntgen rays or the radiation given off by uranium to fall upon it. A careful study of the facts shows that it is probable that some of the atoms have been broken up by the radiation, and that their oppositely electrified parts are scattered among their unaltered fellows. Such a gas is said to be ionized.

Thus by these two distinct lines of argument we come to the conclusions: 1, that the presence of electrified particles promotes the formation of mist, and, 2, that in an ionized gas such electrified particles are provided by the breaking up of atoms.

The two conclusions will mutually support each other if it can be shown that a mist is easily formed in ionized air. This was tested by Mr. Wilson, who showed that in such air mist is formed as though nuclei were present and thus in the cloud we have visible evidence of the presence of the divided atoms. If, then, we can not handle the individual molecules, we have at least some reason to believe that a method is known of seizing individuals, or parts of individuals, which are in a special state, and of wrapping other matter round them till each one is the centre of a discrete particle of a visible fog.

I have purposely chosen this illustration, because the explanation is based on a theory —that of ionization—which is at present subjected to hostile criticism. It assumes that an electrical current is nothing more than the movement of charges of electricity. But magnets placed near to an electric current tend to set themselves at right angles to its direction; a fact on which the construction of telegraphic instruments is based. Hence, if the theory be true, a similar effect ought to be produced by a moving charge of electricity. This experiment was tried many years ago, in the laboratory of Helmholtz by Rowland, who caused a charged disk to spin rapidly near a magnet. The result was in accord with the theory; the magnet moved as though acted upon by an electric current. Of late, however, M. Crémieu has investigated the matter afresh, and has obtained results which, according to his interpretation, were inconsistent with that of Rowland.

M. Crémieu's results are already the subject of controversy,* and are, I believe, likely to be discussed in the Section of Physics. This is not the occasion to enter upon a critical discussion of the question at issue, and I refer to it only to point out that though, if M. Crémieu's result were upheld, our views as to electricity would have to be modified, the foundations of the atomic theory would not be shaken.

It is, however, from the theory of ions that the most far-reaching speculations of science have recently received unexpected support. The dream that matter of all kinds will some day be proved to be fundamentally the same has survived many shocks. The opinion is consistent with the great generalization that the properties of elements are a periodic function of their atomic weights. Sir Norman Lockyer has long been a prominent exponent of the view that the spectra of the stars indicate the reduction of our so-called elements to simpler forms, and now Professor J. J. Thomson believes that we can break off from an atom a part, the mass of which is not more than one-thousandth of the whole, and that these corpuscles, as he has named them, are the carriers of the negative charge in an electric current. If atoms are thus complex, not only is the *a priori* probability increased that the different structures which we call elements may all be built of similar bricks, but the discovery by Lenard that the ease with which the corpuscles penetrate different bodies depends only on the density of the obstacles, and not on their chemical constitution, is held by Professor Thomson be be "a strong confirmation of the view that the atoms of the elementary substances are made up of simpler parts, all of which are alike."

* See *Phil. Mag.*: July, 1901, p. 144; and *Johns Hopkins University Circulars*, xx, No. 153, May-June, 1901, p. 78.

A LIFETIME'S PROGRESS.

When our grandfathers were boys, or back in what are often called the "good old times," there were no telegraphs or telephones or trolley cars or electric lights, nor any of that astonishing retinue which electrical invention has brought in its train during these later years. Truly, our ancestors were ignorant of much of the comfort of life, though doubtless they made up in serenity of mind what they lacked in conveniences; but how far we have progressed in certain directions is so little generally known that a comparison is interesting to show it. Incidentally, any study of the conditions of existence in 1830, for example, will show that electricity has been probably the largest factor in the changes that have taken place since then.

In 1830 the very name of electricity was known only to savants. In a few schools there were examples of Leyden bottles, frictional plate machines and the Volta pile, with perhaps a Davy cell or two, but the lightning-rod was the only electrical apparatus in use. Popular ignorance on the subject was hardly more dense than that of teachers of natural philosophy; electricity was an unknown but inviting field.

Journeys by land were then made in private carriages, on horseback, or in public coaches where roads were good. The transatlantic crossing was made in sailing vessels requiring six weeks for the voyage, and coastwise trips were matters of a delightful uncertainty. To go far inland in America meant a journey in canoes and afoot through a pathless wilderness beset with savages. To send a message from New York to Philadelphia and obtain a reply took nearly a week; to London it took three months. Only in a few cities had that brilliant and dazzling illuminant, gas, usurped the place of the ceremonial wax, or more usual and economical tallow candle. Streets were either dark or lighted by lamps or lanterns, maintained often by private subscription. Heavy freight was moved by ship or canal boat; if water facilities did not exist the freight did not move far. A myriad messengers were employed in cities as necessary adjuncts to the transaction of business. Cities were smaller then and most persons resided under the same roof that covered their places of business.

When it was announced to an incredulous age that messages might be sent to great distances practically instantaneously the statement was accepted as manifestly insane. Such a thing was incredible on its face; it never had been done and could never be done. But it was done. And this first practical utilization of electricity, the telegraph, led the way for all the rest, because it made the public mind ready to receive any statement made from authoritative quarters concerning the wonder-working power of electricity. So, when the telephone was announced it was received with wonder and satisfaction, but not with the utter incredulity that greeted its predecessor. People were ready to admit that electricity could do anything after they saw the telephone.

If we compare the condition of the average man seventy years ago and to-day it will be hard to decide whether the development of electrical appliances or of transportation facilities has done more to improve it. The telegraph and telephone have caused the world to shrink in size, and emancipated countless messengers to more productive employment. The electric light has vastly extended the working hours of the race and made the evening hours both more attractive and safer. The trolley car has been the chief of municipal blessings, and has made cities cleaner, quieter, more habitable. All these things, and more, electricity has done in seventy years, and thus has made an ever-widening difference between the citizen of to-day and his forefathers. What the future holds and what development we may expect can be judged only by reference to what has been done in the past.

THE RAPID TRANSIT SITUATION IN BOSTON.

BY LOUIS BELL.

Since the Boston elevated railway went into service some three months ago there have been published in the technical press divers enthusiastic articles on the engineering features of the enterprise, but, so far as the writer is aware, there has been very little reference made to the actual effect upon the rapid transit situation and upon the outlook for future improvements. There is much to be said on this topic, and while it can not be altogether commendatory the writer believes that an analysis of the net results in the light of the present status of electric traction, both here and abroad, may be not without interest to engineers or without value to the citizens who bear the burden.

No city of similar size ever needed or wanted an elevated road less than Boston. Rights and franchises for such an enterprise had been buffeted about for the last 20 years and nothing was more clearly evident than that as an independent factor in rapid transit an elevated line would neither fill any long-felt want nor have any well-founded hope of prosperity. One trivial fragment of roadway linking the North and South Union stations, would have met a real public need, but for the rest Boston is accessible from enough directions by steam roads and electrics to have been permanently free from the incubus of elevated roads, if the situation had been treated with a little forethought.

As a city grows congestion of surface traffic is a natural consequence of increased travel, but it can become burdensome and serious only when mistakes in distribution of traffic are made. If traffic gathered along a dozen streets is forced into one in pursuit of the useless purpose of landing every passenger at the same point, congestion is a necessary result. So when in Boston old companies were consolidated and old lines were operated in connection with new ones, matters soon reached a grave and critical state. The street railway organization was singularly well handled, but physically it was an agglomeration, not a system.

Something had to be done and that something eventually proved to be the construction of the subway. Here was a magnificent opportunity let slip, for while the subway from the engineering standpoint is admirable, it perpetuates the old mistake of crowding all the traffic into a single line of movement and in the main into a single terminus.

Therefore, the subway was foredoomed to be only a palliative where it might have been a radical cure. Traffic through it was skillfully managed, but there could in the nature of things be but one result. Doubtless the wiser heads in the business scented failure afar, for long before the actual work on the subway was completed the elevated railway scheme was again pushed to the front. The inner history of this matter will probably never be veraciously written. The revival of a project anathema from every public point of view, just when the West End surplus was ripe for the plucking and the subway was available for averting desperate opposition to an elevated road through the heart of the city; the hastily grabbed lease on any terms that would stifle competition, when competition meant disaster; the persistent effort to put back the surface tracks so as more completely to divert the subway from its supposed original purpose; all these form a story that he who runs may read—too recent to need discussion. Likewise the sessions of the "Third House" that made Beacon Hill an offence to the nostrils of honest men, may be here passed over as irrelevant.

And now we have the elevated—from Dudley street to Sullivan square and around the loop between the stations. What is its character as an engineering project, as a factor in Boston's rapid transit facilities, and as a means to better ends in the future?

To begin with, the elevated structure itself is much less offensive than some of its class. There was an evident attempt to get a combination of lightness and strength that should not utterly condemn every street through which it passed. So far as defacing the streets and shutting out light is concerned the Boston elevated road is far less objectionable than some others that could be named. The light looking structure seems, however, to be singularly resonant, so that the noise of the trains is very much in evidence. It is very hard to make a quantitative estimate of noise, but in the writer's judgment, the Boston line is quite the noisiest of its kind, far more troublesome in this respect than the New York "L" with its locomotives. How far this resonance is due to the design of the structure and how far to the high speed, quick acceleration, and multiplicity of driving wheels one could hardly tell without an experimental study of the case.

The electrical equipment is admirable, most skillfully planned and carefully operated. In particular, the acceleration of the train is at once very quick and very smooth, much less troublesome to the passenger than the ordinary acceleration of a surface car. The braking, too, is admirably managed for the comfort of the load. Part of this excellence is, of course, due to the careful design of the apparatus, but in no small measure the result should be credited to careful instruction and supervision of the operating force. The personnel of the Boston street railway system is far and away the finest with which the writer has ever come in contact in his professional wanderings. It has long been a picked body of men, from the heads of departments to the common laborers. This excellence should rightfully be credited by the public to the personal account of Mr. C. S. Sergeant, to whose untiring energy the system owes so much in other respects.

There has been much complaint of injury and annoyance from minute particles of steel detached from the third rail and dropped into the street below. One need only look at the contact shoes, when the trains are under way, in order fully to realize the cause of the trouble and its probable serious magnitude. So long as the present third-rail system is used there is a reasonable certainty that steel dust will be raised in considerable amounts, but there is no good reason why this dust should be allowed to fall into the street. If the third rail were so guarded as not to be a grave source of danger to human life it would not be likely to remain troublesome in the lesser matter of injury to the eyes. An elevated road is in far less danger in using an unguarded third rail than is an interurban surface road, since trespassers on its track are fewer. But even the lives of employés are of some value, and there is not the slightest reason, save the pitiful one of economy, for neglecting so to protect the third rail as to render accidental contact with it highly improbable. The excuse is often made that no road has found it necessary to take such precautions, but until they are taken there will steadily accumulate an ugly record of serious or fatal accidents, for which there will some time be a grim day of reckoning.*

Other safety precautions have been extremely well looked after. The automatic block system is quite the most complete of its kind ever installed and seems thus far to be eminently successful in its operation. In such matters of equipment the road is generally a model.

But while the road is an engineering success, it must be regretfully admitted by any one who has studied the situation

* Even while this article was in the printer's hands one more was added to the list of the dead.

without bias that as an addition to the general transit facilities of Boston it has very little real value as at present administered. In theory it greatly reduces the time required to go from Dudley street to Sullivan square, or from either point into the city. But in point of fact the normal traffic between these termini is not large and the number of passengers between either and the centre of Boston, while considerable, is by no means great enough to support the elevated road as a bona-fide rapid transit enterprise.

It was from the beginning obvious that having the elevated structure the public must be forced to patronize it, willy-nilly, if it was to justify its existence. The result has been, therefore, that instead of relieving the already overcrowded surface lines, and giving added facilities for easy travel, the surface lines have been rapidly pulled off, and the overcrowding transferred to the elevated cars without any material saving of time.

In the long run the criterion of rapid transit is the time consumed from dwelling place to place of business. The passenger gains nothing by increased speed over a part of his route, if he equally loses time on the remainder by waiting at a transfer station, or being forced to walk from an elevated station to his office. He gains little, therefore, unless the fast run is long enough to save considerable time, and he loses in comfort more than enough to offset any but a great saving in time if he is compelled to change cars at all.

It is in this point that the Boston elevated system utterly fails as a means of rapid transit. The policy of building a trunk line through the city, and driving traffic upon it by removal of other facilities is one that may tend to economy of operation, but from the standpoint of the publicist it should not be tolerated for a single day.

It was provided by law that the surface facilities should not be decreased unless equivalent facilities were otherwise established. As a matter of fact no service with infrequent stops along a single line can ever be considered as properly a full equivalent of surface cars along several parallel lines in the same direction. If such a substitution is permitted, it is because some one is derelict in his duty to the public.

Express traffic can not replace local traffic, however successfully it may supplement it. The Boston system is the only one in the world on which so audacious an experiment has been tried on a considerable scale, and the results have been such as utterly to condemn it now and forever. And it is a particularly unfortunate experiment to have tried in Boston, because there is a drawbridge over navigable waters of the United States on the trunk line itself.

Incidentally, the change from surface cars to elevated cars is in summer a change from comfort to discomfort. The former are open cars, the latter closed, and provided for their passage through the subway with 20 incandescent lamps apiece. The result during the heated term resembled for the hapless passenger a sudden plunge into the hot room of a Turkish bath. Moreover, the old street railway adage that the profit is from the passenger who stands, seems to have been scrupulously heeded in arranging the elevated schedule, so that the crowding is strongly suggestive of a Cambridge car on the afternoon of the Harvard-Yale football game.

The long and short of the whole matter is that when Boston needed not only every surface car that the tracks could accommodate, but all the added facilities that the elevated road could give, it merely changed the place and kept the pain, reinforced by discomfort.

Rapid transit in a great and growing city is a serious problem at best, and errors of judgment in attempting its solution may reasonably be expected—but such errors should be rectified, not persisted in.

The Boston situation is, and long has been, a bad one. Its weakest point is the tendency to utilize a single working terminal in insufficient space at Park street. This might have been remedied in the construction of the subway, but it was not. The next logical step would have been the building of a Washington street subway with an independent general terminus for southbound traffic. But as it is we have the elevated road and must make the best of it.

The use now made of that structure is certainly not the best possible from the standpoint of public utility. It is at least an open question whether for the present and probably for a long time to come, it could not have been wisely employed merely as an avenue for cars, originating in the region beyond the termini and carried to their destination *via* the elevated road instead of on the surface. If advisable such cars could become multiple-unit trains on the elevated section—trains that could break up and scatter as soon as they reached the surface without the scuffling pandemonium now raised in the change at the termini. Every surface track thus cleared could be utilized again as a surface line without increasing the present congestion, and the whole unpleasant situation would have been greatly relieved. The speed on the elevated section would doubtless be somewhat reduced by such a procedure, but the abolition of a change of cars would far more than compensate for this loss.

The present policy is not only a public injury for the present, but a menace for the future. If adhered to, every additional elevated line will be a fresh source of inconvenience. Citizens who do not live on the immediate course of the road will find themselves hampered continually by lack of surface facilities. It may be that the ideal city will have no tracks in its streets, but it assuredly will not have them raising a din overhead. If the steam railroads running out of Boston fully appreciated their opportunity, they would put up a most effective and destructive sort of competition. It would probably mean electric traction, but they would gain by the substitution and could put their passengers through in comfortable cars without change.

There is another serious phase to the present condition of affairs. The growth of greater Boston is very largely determined by and along the lines of rapid transit. If the surface lines are steadily curtailed and their traffic is turned into a few trunk lines, the effect on property values in the regions stripped of their facilities for transportation is likely to be very serious. The expansion of the city can not safely be left in the unrestrained hands of any organization, however well disposed.

There is a time coming when the lease of the old West End system will terminate. If the present work goes on and the growth of the city is directed for the next 15 years or so by the guidance furnished in the manner which has been indicated, in what condition for the resumption of independent business would the surface lines be if it were judged wise not again to entrust the rapid transit of the city to a single corporation? And on what terms, if at all, would the lease be likely to be renewed? Particularly, what would be the result if the present company were allowed to make a lease of a Washington street subway, breaking joints, as it were, with the West End lease? It may be needless to look ahead so far, but a city is not for a year or a decade, and must look well to its future.

These comments on the Boston situation are written in no spirit of animosity, but merely to bring sharply to public attention some of the phases of the matter which have received insufficient attention. The problem of rapid transit is many-sided, and must be viewed from all directions to be seen in proper perspective. Its solution is a matter of the highest civic importance.

THE THEORY OF ALTERNATING DYNAMO ELECTRIC MECHANISMS—XLIV.

BY W. ELWELL GOLDSBOROUGH.

Example 22.

Given: A balanced three-phase system, of which Fig. 104 can be taken as a diagrammatical illustration. Here, each of the alternators E^I, E^{II}, and E^{III} develops electro-motive forces of 1,000 volts. Further, the machines are operated synchronously, and their armatures are so fixed relatively to one another that the electro-motive forces which they develop have a phase displacement of 120 degrees between them. The system being balanced, the resistances r_1, r_2, and r_3 have the same values, each being equal to 17.3 ohms; likewise, the reactances x_1, x_2, and x_3 are each equal to one another and to 10 ohms.

Determine the values of the currents flowing in the three circuits, the angles of lag of these currents behind their respective line electro-motive forces, and the phase relation of the electro-motive forces developed by the alternators to the line electro-motive forces which they severally give rise to.

Since the circuits are arranged in star connection and have constants of the same value, the system is so balanced that each of the generators may be treated as acting on its individual circuit alone. In solving the problem, then, we can, to all intents and purposes, treat the circuit $O'A_1O$ as if it were a single-phase circuit influenced by the alternator E^I, and returned upon itself by a circuit-closing connection bridged over between the points O′ and O. With this understanding of the equivalent conditions, it is a simple matter to determine the value of the current flowing through the generator and in the line of the first circuit. By substituting the electro-motive force and the constants of the circuit in Equation 54

$$I_1 = \frac{1{,}000}{\sqrt{17.3^2 + 10^2}} = 50$$

we find that I_1 has a value of 50 amperes, and further

$$\phi_1 = \tan^{-1}\frac{10}{17.3} = 30°$$

that this current lags behind the electro-motive force appearing at the terminals of the circuit by an angle of 30 degrees.

The solution of our problem is now complete, since like currents of 50 amperes each will flow in the second and third circuits, and lag 30 degrees behind the electro-motive forces impressed upon the second and third circuits. Moreover, as the resistances and reactances of the alternator armatures are negligible, and each of the three circuits can be considered as a separate, single-phase system, the electro-motive forces developed by the generators will, in each case, be equal and opposite to the electro-motive forces apparent at the circuit terminals.

In Fig. 110, OB_1, the current flowing in the first circuit has a value of 50 amperes, and lags 30 degrees behind the electro-motive-force vector OA^I. This electro-motive-force vector is equal to both the electro-motive force impressed at the terminals of the circuit OA_1, and the electro-motive force developed in the armature of generator E^I. Further, the

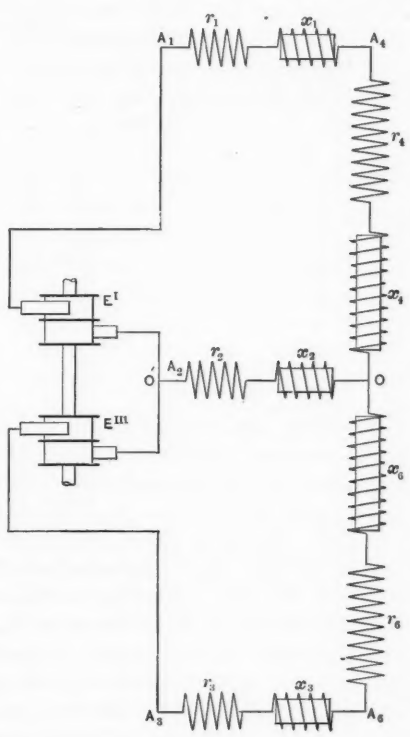


FIG. 111.—ALTERNATING MECHANISMS.

resistance electro-motive force of the first circuit, $OC_1 = 866$ volts; and the reactance electro-motive force of the first circuit, $C_1A^I = 500$ volts.

The data just given apply equally well to the vectors of the equal triangles OC_2A^{III} and OC_3A^{III}, the only difference being that the space relation of like vectors in each triangle differs by 120 degrees. The currents flowing in the three circuits, when combined in a closed polygon, produce the equilateral triangle bounded by the points $B^IB^{II}B^{III}$, each of the sides of which has a value of 50 amperes. Thus it is seen that the treatment of a balanced three-phase, star-connected system is reduced to very simple terms.

THE GRAPHICAL ANALYSIS OF COMMERCIAL TWO-PHASE, THREE-WIRE SYSTEMS.

On page 92, attention was called to the fact that the discussion of two-phase, three-wire systems as there developed, while exact in principle, was not directly applicable to commercial working without modifications. Fig. 93, used to diagrammatically represent the two-phase, three-wire system treated, shows three circuits *which do not materially differ as regards the magnitude of their constants* influenced by two alternators. This arrangement is not used in practice for the reason that the resistance and reactance of the *central circuit* of Fig. 98 is entirely too high. This is the equivalent of saying that receivers are not in practice connected in series with the common line (OA_2) of a two-phase, three-wire system.

Fig. 111 shows the scheme of connections employed in efficient systems of this class. In this figure, the parts OA_4 and OA_6 diagrammatically represent the receivers, which are supplied with power from a two-phase generator. This generator, for present purposes of illustration, is represented as two single-phase alternators driven synchronously. The circuits A_4A_1, OO', and A_6A_3 represent the distributing lines which lead from the generator collector rings to the receiving elements.

Now, in order that the peculiarities of two-phase, three-wire distribution may be forcefully brought out, the system shown in Fig. 111 will be assumed to be a balanced system. Therefore, in the receiving circuits, the resistances r_4 and r_6 are equal, and the reactances x_4 and x_6 are also equal. The line resistances r_1, r_2, and r_3 are equal to one another, and $x_1 = x_2 = x_3$. However, it must be remembered that, in this case, the line constants are in no wise equal to the receiver constants; in other words, of the total power developed by the alternator and delivered to the system, we will assume that approximately 20 per cent is absorbed in the lines, and that 80 per cent is absorbed by the receivers. These values compare with those found in only very inefficient systems of this class, but are used in order that the line electro-motive-force vectors may have appreciable values in the graphical diagram relatively to the electro-motive-force vectors of the receiving circuits. This statement of the conditions admits of our taking the impedance of each of the lines A_1A_4, $O'O$, and A_3A_6 as proportional to unity, and the impedance of each of the receiving circuits OA_4 and OA_6 as proportional to 8. To simplify matters, we will neglect the resistance and reactance of the alternator circuits.

Selected Chapters in Electrochemistry.

By Harry C. Jones.

CHAPTER VII—CALCULATION OF THE ELECTRO-MOTIVE FORCE OF ELEMENTS.

PART II.

THE CALCULATION OF THE DIFFERENCE IN POTENTIAL BETWEEN A METAL AND A SOLUTION OF ONE OF ITS SALTS.

We have already seen how it is possible to calculate potential from the osmotic pressure of the solutions around the electrodes and have also studied the solution-tension of metals, and what takes place when a metal is immersed in a solution of one of its salts. We shall now apply these two fundamental conceptions to the calculation of the difference in potential between a metal and a solution of one of its salts in which it is immersed.

Let us take a metal with a solution-tension P, and dip it into a solution of one of its salts, in which the metal ions have an osmotic pressure p; a difference in potential between the metal and the solution will result, and this can be calculated as follows from the foregoing conceptions.

The metal has a solution-tension P, this can be converted into ions under an osmotic pressure P, without any work being done. If the osmotic pressure of the metal ions in the solution is p, to convert a metal of solution-tension P into ions of an osmotic pressure p requires the same amount of work, or the same amount of work is obtainable, as if we started with the metal in the form of ions under an osmotic pressure P, and transformed them to a condition where the osmotic pressure was p. Since the laws of gas-pressure apply to osmotic pressure, we can calculate the amount of work obtainable from the process where ions under an osmotic pressure P are transformed into ions under an osmotic pressure p, from a gas under a gas-pressure P, when transformed to a gas-pressure p. In the first part of this chapter this was shown to be, for a gram-molecular weight of a gas;

$$RT \ln \frac{P}{p}$$

We have also seen that this is equal to the electrical energy which can be obtained from such a process, since the work done is transformable, quantitatively, into electrical energy, when we are dealing with solutions under suitable conditions. The electrical energy E_e is equal to the potential π times the capacity E_0—

$$E_e = \pi E_0$$

If then we equate these two equal values we have;

$$\pi E_0 = RT \ln \frac{P}{p}$$

If now we introduce the numerical values already given for $\frac{RT}{E_0}$ and solve for π, at the same time changing to Briggsian logarithm we would have:

$$\pi = 0.058 \log \frac{P}{p}$$

The difference between the potential of a metal and a solution of one of its salts in which it is immersed is, then, equal to a constant, which, for 290 degrees absolute temperature, or the temperature of the ordinary room, is 0.058 volt, into the logarithm of the solution-tension of the metal, minus the logarithm of the osmotic pressure of the metal ions in the solution. We shall now apply the conceptions with which we have become familiar to a few typical elements.

TYPES OF ELEMENTS.

We know a large number of primary cells, and these are constructed of very different substances for the electrodes, and of solutions of very different electrolytes. In all such cells it should be observed that we have both classes of conductors; those of the first class conducting like the metals and serving as the electrodes, and surrounding these are conductors of the second class or solutions of some electrolyte or electrolytes. To construct a primary battery it is then necessary to have conductors of the first class bordering on conductors of the second class.

A system of classification has been adopted for primary cells, which simplifies the whole class very greatly. If during the action of the cell its electromotive force does not change, it is called a *constant* element. If it does, the element is *inconstant*. In order that the electromotive force of an element should remain constant it is necessary that the process which goes on in the cell should remain unchanged as long as the cell is in action.

Through some constant elements a current can be passed in a direction the opposite to that in which the current would normally flow, without changing the electromotive force of the element. Such constant elements are known as *reversible*. In order that an element should be reversible it is necessary that the reverse current should not change the nature of the element. This can only happen when the electrodes are immersed in solutions of their own salts. In such cases the reverse current simply causes a deposition of a small amount of one metal and the solution of a corresponding amount of the other. When the reverse current is passed for a very short time the nature of the element remains essentially unaltered. There are other constant elements through which a current can not be sent in the reverse direction without changing the nature of the element and, consequently, its electromotive force. Such constant elements are termed *irreversible*.

We shall take up first a very simple, reversible, constant, element, and apply the conceptions already developed to the calculation of its electromotive force.

A SIMPLE CONCENTRATION ELEMENT.

The simplest primary cell of which we can conceive consists of one electrolyte of two different concentrations, and one electrode. Into a beaker pour a concentrated solution of stannous chloride until it is about half full. Immerse a bar of tin into the solution, of such a length that it is about half covered with the concentrated solution of the salt. Then pour carefully on to this concentrated solution a dilute solution of the same salt, until the beaker is nearly filled.

Let us now see what takes place in the above arrangement. Where the tin is surrounded by the more concentrated solution of stannous chloride, it increases in size due to the separation of the metal from the solution on to the bar. The ions of tin, when they separate in the metallic condition, give up their charges to this portion of the bar, which becomes charged strongly positive. This charge flows along the whole bar, since the metal is a good conductor, and the entire bar of tin becomes charged positively by just so much as there are ions separated as metal on to the bar. If this charge could not escape in some way, the difference between the potential of the bar and that of the solution (which has become negative due to the loss of positive ions) would very quickly become so great, that no further separation of ions in the form of metal on

to the bar would be possible. The original action would very quickly cease, were it not for the fact that the bar, when charged positively, is just in the condition most favorable to giving off ions to the more dilute solution of stannous chloride, and it does so. When a metal passes into solution as ions it must obtain positive electricity from some source. In this case the positive electricity is already present on the bar, the atoms take it up, become ions, and pass into the solution. This lowers the potential of the bar again and more ions can separate from the solution; and the process is, thus, a continuous one.

The action of this, the simplest of all primary elements, is as follows: Tin ions separate from the more concentrated solution of stannous chloride, on to that portion of the bar immersed in this solution. They give up their charges to this portion of the bar, which is then conducted to the portion immersed in the more dilute solution. Here atoms of tin take up the positive electricity, become ions, and pass into solution. The chlorine ions have, meanwhile, traveled from the more concentrated toward the more diluted solution, against the direction of flow of the current.

The action of this cell, like the action of all concentration elements, is such as to decrease the concentration of the more concentrated solution, and to increase the concentration of the more dilute solution. This would continue until the concentrations of the two solutions would become the same, when the element would cease to be an element.

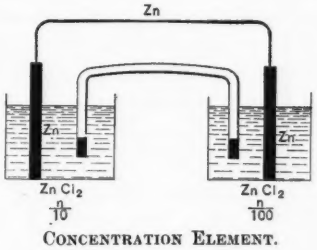
It would be extremely difficult to measure the electromotive force of such an element as that just described, and it would, therefore, be of little value to calculate it, since it could not be verified by experiment. We will, then, use this element as an illustration of the very simplest concentration element, and proceed to apply our deductions to a concentration element whose electromotive force can be measured.

The element which we shall study, both theoretically and practically, consists of two bars of zinc, immersed, the one in a more concentrated solution of zinc chloride, and the other in a more diluted solution of the same electrolyte. The arrangement would be illustrated by the following sketch.

Two bars of zinc serve as the electrodes, and are connected with a strip of zinc. These dip into solutions of zinc chloride of different concentrations. The concentrations are represented for convenience as one-tenth and one-hundredth normal. The two solutions are connected by means of a siphon, filled either with the tenth or with the hundredth-normal solution. The ends of the siphon are filled with loose rolls of filter paper, to prevent a mechanical mixing of the solutions, and to lessen the rate at which one solution will diffuse over into the other. The filter paper offers a comparatively slight resistance to the passage of the current.

It will be observed that both electrodes are of the same metal, and they are immersed in solutions of the same electrolyte; the only difference on the two sides of the cell being that the solutions of the zinc chloride are of different concentrations. Hence the name, *concentration element.*

The action of this element will be very readily understood from the explanation of the action of the simpler concentration element, consisting of one bar of tin immersed in two solutions of stannous chloride. Take first the side of the element on which the electrolyte is more concentrated. Zinc is an element, as we shall see, which has a very high solution-tension. This is always much greater than the osmotic pressure of even the most concentrated solutions of zinc chloride which can be prepared. When a bar of zinc is immersed in any solution of zinc chloride, it always sends off some ions into the solution, and establishes the double layer in the sense to oppose the further ionization and solution of the zinc. The zinc bar then becomes negative and the solution positive. Suppose at first that the circuit is not closed, this will take place on both sides of the cell until equilibrium is established between the solution-tension of the zinc and the electrical double layer formed. It will, however, be remembered, that when the solution-tension of the metal P is greater than the osmotic pressure of the metal ions p, $(P > p)$ the double layer will be formed so as to assist the osmotic pressure or the smaller value, in overcoming the larger value or the solution-tension. In such cases equilibrium will be reached when the sum of the osmotic pressure of the metal ions, and the action of the double layer are just equal to the solution-tension of the metal. Therefore, the larger the osmotic pressure, the smaller the action of the double layer which will be necessary to equalize the solution-tension.



CONCENTRATION ELEMENT.

The osmotic pressure of the zinc ions is, of course, larger on the side of the cell containing the more concentrated solution,* and, consequently, the action of the double layer will be less on this side of the cell. But the action of the double layer depends on the difference in potential between the metal and the solution, and this depends upon the number of zinc ions which pass into solution. On the side of the cell containing the more concentrated solution, the zinc will send fewer ions into the solution than on the opposite side, and, consequently, its potential will not be as much reduced as on the other side. The bar of zinc in the more concentrated solution, like the bar in the more dilute, will become negative, but not as much negative as the bar in the more dilute solution.

Suppose, now, the two sides of the cell are connected, what will happen? The bar in the more concentrated solution is less negative than the bar in the more dilute; consequently, when the two are connected a current will flow from the former to the latter, or the former will be the positive pole. Upon this pole, when the circuit is closed, zinc will be deposited. The zinc ions give up their charges to it and separate in the metallic condition, and, consequently, this becomes the cathode. On the other side of the cell zinc atoms are taking up positive charges, becoming zinc ions, which separate from the bar and pass into solution. This bar, having lost negative electricity, becomes the negative pole or the anode. The action of the cell is, then, to decrease the number of zinc ions on the more concentrated side, and to increase the number on the more dilute side; the current flowing on the outside from the pole immersed in the more concentrated solution to the pole immersed in the more dilute. On the inside the current flows in the opposite direction, from the pole immersed in the more dilute solution; and, since the anions move against the current, the chlorine ions move over toward the pole immersed in the more dilute solution of zinc chloride. The more dilute solution thus becomes continually more concentrated, and the more concentrated more dilute. So much by way of explanation of what takes place. Let us

*A word of explanation here may almost seem superfluous; but the error is frequently made of regarding a more dilute solution as containing the larger number of ions, because the percentage of dissociation is larger in the dilute solution.

now apply the conceptions and deductions with which we have been dealing in this type of concentration elements. The potential on the more concentrated side between the metal and the electrolyte would be expressed thus:

$$\pi_1 = \frac{0.058}{v} \log \frac{P}{p_2}$$

where v is the valence of the zinc ion $= 2$, P the solution-tension of zinc, and p_2 the osmotic pressure of the zinc ions in the solution. The potential on the other side is:

$$\pi_2 = \frac{0.058}{v} \log \frac{P}{p_1}$$

where the common symbols have the same significance, and p_1 is the osmotic pressure of the zinc ions in the more dilute solution.

The electromotive force of this, as well as any other primary cell, is the difference between the potentials on the two sides, therefore:

$$\pi = \frac{0.058}{v} \log \frac{P}{p_2} - \frac{0.058}{v} \log \frac{P}{p_1}$$

$$= \frac{0.058}{v} \log \frac{p_1}{p_2} \text{ and since } v = 2$$

$$\pi = 0.029 \log \frac{p_1}{p_2}$$

The metal being the same on both sides of the cell has the same solution-tension* on the two sides, and being of equal value and opposite sign disappears from the final equation.

From anything which has been said thus far, we might conclude that this was the entire story of the concentration element. There is, however, still one factor which has not been taken into account—the change in the concentration of the solutions which is taking place while the current is passing, due to the movement of the ions.†

"If E_0 electricity passes from the electrode into the electrolyte, a gram-molecular weight of univalent cations separates from the electrode, dissolves, and increases by unity the concentration around this electrode. But, at the same time, cations are moving from this electrode, with the current, over toward the other electrode. The amount depends upon the relative velocities of anion and cation. If we represent the relative velocity of cation by c, and of anion by a, the number of the cations which will move over with the current is $\frac{c}{c+a}$. The increase in the concentration, due to a gram-molecular weight of cations passing into solution, is then:

$$1 - \frac{c}{c+a} = \frac{a}{c+a}.$$

This factor is to be multiplied into the former equation to obtain the osmotic work, which can then be equated to its equal—the electrical energy. Let n_i represent the number of ions in a gram-molecular weight of the electrolyte:

$$\pi = \frac{a}{c+a} \frac{n_i RT}{v e_0} \ln \frac{p_1}{p_2};$$

$$\text{or,} \quad \pi = \frac{a}{c+a} \frac{n_i}{v} 0.058 \log \frac{p_1}{p_2},$$

We have now taken into account all the factors involved in this simple concentration element. The osmotic pressures of the cations of the electrolyte, the solution-tension of the metal used as electrodes, and the velocities of the ions, have all been considered. The electromotive force of such an element depends, according to the final equation, chiefly upon the relative osmotic pressures of the cations of the electrolyte used; but in addition upon the factor $\frac{a}{c+a}$, which must be taken into account for the reasons given above.

This equation has been applied to concentration elements analogous to the one just described, and their electromotive force calculated from the osmotic pressures of the electrolytes used, and the relative velocities of their ions. The electromotive forces of the same elements have then been measured, and the calculated values compared with those found experimentally. The two sets of values have been found to agree very satisfactorily in every case where a comparison has been made.

In an element such as has just been described, the only sources of potential are at the surfaces of contact of the electrodes with the electrolytes, and the surfaces of contact of the two electrolytes with each other. There is no source of potential at the contact of the two electrodes, since they are of the same metal. We should like to know how much of the electromotive force was generated at the contact of the metals with the electrolytes, and how much at the contacts of the two electrolytes.

The magnitude of the potential at the contact of the electrolytes can be calculated and also measured, as Nernst has shown. To do this we must exclude the other source of potential, *viz.*, that at the contact of the electrodes with the electrolytes, and this has been done in a form of element which we shall now study.

THE LIQUID ELEMENT.

To determine the potential at the surface of contact of two electrolytes, the same metal must be used for electrodes on both sides of the cell, and both electrodes must dip into solutions of the same electrolyte, and of the same concentration. Such elements have been studied by Nernst,* who explained for the first time the action of the liquid element. As an example of the liquid element he cites the following:

$$\frac{n}{10} KCl - \frac{n}{100} KCl - \frac{n}{100} HCl - \frac{n}{10} HCl - \frac{n}{10} KCl$$

The platinum electrodes dip into the tenth-normal solutions of potassium chloride at the two ends, so that any potential generated here on one side, would be exactly balanced by the equal potential of opposite sign on the other side of the cell. The only sources of potential in such an element would be at the contacts of the solutions of the electrolytes.

The question which would naturally arise in connection with such an element is, why should there be any potential at all at the surface of contact of two electrolytes? Nernst thinks that this is due to the unequal velocities with which the ions move in a solution. The faster ion is held back in its movements by the slower, and the result is a tension which manifests itself as a potential. The words of Nernst in this connection will be given, introducing the symbols c and a for the relative velocities of cation and anion, respectively, instead of u and v, which were employed by Nernst, and have since been used by all who have discussed these problems.

"Since† in electrolytes electricity can move only with the ponderable masses, the ions, we will find the difference in potential which exists between two solutions of the same electrolyte of different concentrations, which are in contact, by calculating the work required to transport the masses carrying the two kinds of electricity from the one solution to the other.

According to the views of Hittorf, and especially those developed later by Kohlrausch, the conductivity of a current of intensity i, in an electrolyte in which the cation has the velocity c, and the anion the velocity a, is always found as follows:

In unit time $i \frac{c}{c+a}$ of positive electricity moves in the direction of the current, and $i \frac{a}{c+a}$ of negative electricity moves in

*The solution-tension of a metal is a constant, regardless of the concentration of the solution at its salt in which it is immersed.

†The following paragraph is quoted from Theory of Electrolytic Dissociation, pp. 240-241.

* *Ztschr. phys. Chem.*, iv, 140.

† *Ztschr. phys. Chem.*, iv, 136.

the opposite direction. We have, therefore:

$$*E' = \frac{c}{c+a};\ E'' = \frac{a}{c+a}$$

To calculate the work required to transport the positive ions combined with E′ from the more diluted to the more concentrated solution, and the negative ions combined with E″ from the more concentrated to the more dilute solution; let p_1 be the (osmotic) pressure of the anions and, of course, also of the cations, in the one solution, and p_2 in the other solution. In order to transport the positive electricity E′ from the one to the other solution, together with the ponderable masses combined with it from the pressure p_1 to the pressure p_2, and at the same time the ponderable masses combined with negative electricity E″ from the pressure p_2 to the pressure p_1 the following amounts of work would be required:

$$\frac{c}{c+a}\int_{p_1}^{p_2} v\,dp \text{ and } \frac{a}{c+a}\int_{p_2}^{p_1} v\,dp$$

where v is the volume occupied by the mass of the cation (or cations) combined with a plus unit or a minus unit of electricity. If for the purpose of integration we unite the Mariotte-Boyle law in this form:

$$p\,v = p_0$$

where p_0 is the pressure in a solution which contains in unit volume unit plus electricity on the cations, and unit negative electricity on the anions. The sum of the two amounts of work is:

$$P_1 - P_2 = \frac{c-a}{c+a}\,p_0 \ln \frac{p_1}{p_2}$$

P_1 is the potential of the positive electricity E′ and P_2 the potential of the negative electricity E″."

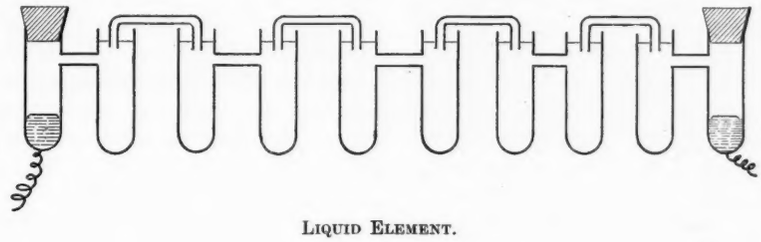
The above words are given because of their importance in connection with the history of this subject. They explain the action of the element in hand for the first time, in a manner which has stood the test of experiment.

The above equation for the electromotive force of a concentration element, interpreted in the symbols and nomenclature used in the earlier part of this chapter, becomes:

$$\pi = \frac{c-a}{c+a}\ 0.058 \log \frac{p_1}{p_2} \text{ volts},$$

where p_1 and p_2 are the osmotic pressures of both cations and anions in the two solutions of electrolytes which come in contact. The arrangement of the vessels which contain the solutions of electrolytes is given by Nernst, as shown in the accompanying sketch.

The sketch explains itself. The electrodes are inserted into the two ends which contain the same solution, and the three intermediate solutions are inserted between the end solutions, as shown in the sketch.



Liquid Element.

Nernst calculated the electromotive force of a number of such elements, and compared the results of calculation with those of measurement. He found a satisfactory agreement between the two in every case. The results show that the electromotive force of a liquid element is always small, being dependent, as will be seen from the formula, mainly upon the relative velocities of the cation and the anion. If these are equal, the electromotive force of such an element would be zero.

Since the electromotive force generated at the surface of contact of electrolytes is very small, we see that the chief source of the electromotive force of primary cells is at the surfaces of contact of the electrodes with the electrolytes.

It was thought for a long time that the chief source of potential was at the surface of contact of the two electrodes, and this error persisted until the epoch-making work of Nernst, which we are now studying, appeared in 1889. The voltaic cell was, therefore, discovered about a century before it was understood and a simple mathematical theory of its action worked out. We have thus far applied the theory to simple primary batteries with one metal as the electrodes. We shall now turn to more complex cells, which are far better known than the simple cases which we have been considering.

A TYPICAL TWO-METAL CELL.

The cells which we have thus far studied are of such simple construction, that they will scarcely be recognized as typical primary batteries by any one who is not familiar with the later developments in electrochemistry. It should be added that such cells have little or no technical value, since they are incapable of furnishing any considerable amount of electricity for any appreciable time.

The primary cells with which we are ordinarily familiar, consist generally of two different electrodes and two different electrolytes. Where the electrodes are surrounded by their own salts, the theory which we have just considered can be applied to them. Let us take a typical example of a two-metal battery, each metal being surrounded by one of its own salts. In practice, the two metals used differ greatly in their solution-tensions; one having a very great and the other a very small solution-tension. Let metal A have a very great solution-tension and be surrounded by one of its own salts; and let metal B have a very small solution-tension and be surrounded by a solution of one of its salts.

Since the solution-tension of A is very great, it will always be larger than the osmotic pressure of the cations in any solution of any of its salts which can be prepared. This metal will, therefore, throw some ions off into the solution, until the electrical double layer formed establishes equilibrium between the number sent into the solution and the number which separates from the solution. This metal will, therefore, become negative with respect to the solution, which will be positive. The potential between this metal and the solution will be:

$$\pi_1 = \frac{0.058}{v} \log \frac{P}{p},$$

v being the valence of the metal, P its solution-tension, and p the osmotic pressure of the metal ions in the solution.

The metal on the other side of the cell has a small solution-tension, and the best results are obtained when the solution-tension of this metal is practically infinitesimal. The osmotic pressure of the metal ions in the solution is, therefore, greater than the solution-tension of this metal, and, consequently, metal will separate from the solution upon the bar. The bar will, therefore, become positive with respect to the solution, which will

*E′ and E″ are the amounts, respectively, of positive and negative electricity.

be negative. The difference in potential between the two will be:

$$\pi_4 = \frac{0.058}{v_1} \log \frac{P_1}{p_1}$$

where v_1 is the valence of the metal, P_1 its solution-tension, and p_1 the osmotic pressure of the metal ions in the solution. The electromotive force of an element constructed of the above two metals, A and B, is the difference between the potentials on the two sides:

$$\pi_1 - \pi_2 = \pi = \frac{0.058}{v} \log \frac{P}{p} - \frac{0.058}{v_1} \log \frac{P_1}{p_1}$$

Since the metals used in constructing primary cells are in general bivalent; $v = v_1 = 2$; when the above expression becomes:

$$\pi = 0.029 \left(\log \frac{P}{p} - \log \frac{P_1}{p_1} \right)$$

This is the formula for calculating the electromotive force of such elements as we are considering. It is only necessary to know the solution-tensions of the two metals in question, and the osmotic pressure of the metal ions in the two solutions, in order to calculate the electromotive force of such a cell. The other factors which come into play, such as the potential at the contact of the two electrolytes, etc., are so small that they can practically be neglected. There are a number of very much more complex elements known, in which we have a metal surrounded by some electrolyte other than one of its salts, or carbon surrounded by a solution of some electrolyte; to such cases the theory in hand does not apply, and we are not able to calculate the electromotive force of such combinations.

Improvements in Marconi's System of Wireless Telegraphy.

Mr. F. J. Cross, of the Wireless Telegraph Company, in Hawaii, has made some improvements in Marconi's system of wireless telegraphy. He has added means of transferring electric impulses automatically to ordinary wires and conveying them by Morse instruments. This apparatus is now in operation between the Waialee telegraph station and the main office in Honolulu. He has also added a device to shake up the filings in the coherer after each impulse. Marconi accomplished this by striking the glass tube with a little hammer, but continual jarring wears away the corners of the filings so that they will not cohere. In place of a hammer Mr. Cross placed a large number of coherers in a cylinder, the axis of the coherers being parallel. When a message is received or sent the cylinder will revolve. As each tube goes to the top it will connect with the receiver and receive an impulse and will then pass around the circuit until it reaches the lowest point. The filings are so packed in the tube that their weight will tend to separate them when the tube reaches a certain position in the revolution of the cylinder.

ELECTRIC RAILWAY APPARATUS—I.*

BY ERNST J. BERG.

With the extended application of electricity to heavy railroad work within the last few years, a number of interesting features have been brought out, the most important being what system to adopt and what apparatus to use in each particular case.

The object of this paper is to discuss the characteristics of the various apparatus, and, to a certain extent, their limitations, which, indeed, have almost entirely the deciding influence on the choice of system. The discussion of storage batteries is purposely omitted since their characteristics are well known and have been written up very fully within the last few years.

Continuous-current generators—By far the greater number of these are of the direct-connected type. Their frequency varies from 6 to 15 or 18 cycles, and in some cases as high as 25 cycles. This latter frequency is adopted when, in addition to commutator, the generator is supplied with collector rings intended to take off more or less of the power as alternating current; that is, when the machines are "double-current generators." With the exception of more extended use of direct-current and double-current generators, which are able to supply alternating as well as direct-current power, very little, if any, radical modification in design or characteristics has been made during the last few years, but the progress has rather consisted in a steady and gradual improvement of design, especially in regard to sparkless commutator and overload capacity. Although the standard machines are over-compounded, in actual operation, as a rule, the direct-current potential is kept constant at all loads, the over-compounding being used only to compensate for drop in speed with the load. When used as double-current generator, the compounding on the direct-current side is taken care of in the same way as when used as a direct-current machine, that is by series winding; and the compounding for the alternating-current load made by phase control, that is, the load, which usually is rotary converters, is made to take leading or lagging currents which react on the machine and thereby raise or lower the voltage, as the demand may be. In order to accomplish this satisfactorily, the double-current generators should have fairly high armature reaction, which means not too close regulation. This high armature reaction, usually less than standard direct-current practice, is not objectionable from the direct-current generator point of view, since the regulation of potential is taken care of by the series field. Nevertheless, it has been customary to ask for a regulation as close as six per cent on the alternating-current side, the intention being not to attempt any phase control, but permit the voltage to drop slightly with the load. Under these conditions, obviously, the closer the regulation the better. The limit is reached when, due to the necessarily slow armature reaction and the many armature circuits in multiple, the cross current caused by slight inequality in pole shape or gap becomes excessive.

Alternating-Current Generators—These are in almost every case directly connected to the steam engine and operated at a frequency of 25 cycles per second. If, however, a considerable portion of the power must be used for lighting, a higher frequency may be used. It must, however, be borne in mind that satisfactory parallel operation depends largely upon the frequency, and that the tendency to hunt, and, in general, the difficulties of operating any installation satisfactorily, increase as the frequency increases. Twenty-five cycles has the disadvantage that it is too low for indoor and for efficient outdoor incandescent lighting, and entirely too low for arc lighting, therefore it is hardly advisable to use it for any kind of lighting, but when such has to be done, it is accomplished by rotary converters or motor-generator sets or frequency converters. Twenty-five cycles has, however, so many advantages for railway work that it must be recommended, at least in all cases where induction motor direct-current generator sets are not advisable. The generators are usually designed for a regulation of about 6 to 10 per cent. In view of the fact that usually a great many are operated in multiple in the same station, and therefore the load on individual feeders does not seriously affect one machine, it is preferable to go to rather high armature reaction, since this limits the maximum flow of current and power in case of short-circuit, and suppresses large cross current when operated in multiple from generators of not too close speed control. The European practice is to design these generators with polar windings for securing satisfactory parallel operation, but this has not been found necessary in America, where strict demands have been made upon the steam engine builders, who thereby not only proportion their machines with great care, but pay particular attention to the flywheel and

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governor construction. These generators are always of the revolving field type, and usually installed in connection with independent flywheel, whereas the practice in Europe is to make the armature of such a great flywheel capacity as to combine the flywheel and armature in one structure. One reason for the universal adoption of the flywheel type in Europe is that in most cases 50 cycles are used. With 50 or 60 cycles, and particularly with high-voltage machines, the diameter of the revolving field is, as a rule, enough to render it available as a flywheel, whereas, with 25 cycles, with relatively low peripheral speed, the cost of an unnecessarily heavy revolving field is often greater than that of an additional flywheel. Almost without exception they are designed for three-phase current and voltages ranging between 2,000 and 13,000, depending upon the distance of transmission, etc. When used for voltages less than 6,000, they have, as a rule, three slots per pole and phase, and for higher voltages, two slots per pole and phase. The poles and the slots are shaped so as to give as nearly a sine wave as can be obtained by using machine-wound coils. (The use of machine-wound coils and entirely open slots is contrary to the European practice, at least until very recently, the practice being to use hand-wound coils in almost entirely closed slots.)

Although smaller alternating-current generators are made with automatic compounding, in no case is such compounding used with large direct-connected machines for railway work, but the control is done by hand, and the fields have only one winding.

Inverted converters—These are in their constants essentially direct-current machines operating at 25 cycles, and are used to transform from direct current as obtained from the station bus-bars to alternating current, which, after being transformed to higher potential, is transmitted to substations a considerable distance from the main station. The use of inverted converters is decidedly more efficient than the use of boosters, and is being introduced considerably. Although an inverted converter and a straight converter, that is, a machine transforming from alternating to direct current, to all appearances are identical, it is not always advisable to use one or the other indiscriminately. An inverted converter should preferably have lower armature reaction than a straight converter, and, consequently, is, as a rule, a larger and more expensive machine. The object of the lower armature reaction is to obtain closer speed control and to prevent, as much as possible, the tendency of the inverted converter to run away in case suddenly an alternating-current load of considerable magnitude or of very low power factor is thrown on. But even with inverted converters of such design it is not advisable to omit speed-limiting devices, which may consist of a circuit-breaker in the direct-current leads in connection with a centrifugal device, or the inverted converter is excited by a special exciter directly connected or belted thereto. Indeed, such exciter or "a compensated exciter" is very essential for the frequency control. The plain exciter may be shunt or compound wound, whereby it is easily seen that as the rotary begins to speed up, the exciter also speeds up and its voltage rises, causing more current to flow through the shunt fields, which has a tendency to prevent acceleration. The compensated exciter, which is also a direct-driven exciter, changes its voltages not only with the speed, but with the phase relation of current, increasing the voltage with lagging current going from the converter and lowering it when leading current is taken, which obviously is just what is wanted for close speed control. The ratio between the alternating-current voltage and the direct-current voltage depends upon the system, characteristics of the machine, etc., and is discussed later in connection with converters proper. It suffices here to state that it is a fraction, or, in other words, the alternating-current voltage is always less than the direct-current voltage. It is therefore obvious that the alternating current delivered from an inverted converter is always of too low a potential to be used directly, and step-up transformers have to be used. In its potential control an inverted converter has not the feature of a direct converter of compounding for the load if required, but the voltage will drop with the load unless made up entirely of converters, which, by taking leading or lagging current, can react upon the inverted converter, but even with such load only a very low compounding can be obtained. Therefore, as a rule, the voltage of an inverted converter will drop with the load. In order to obtain constant potential at the receiving end of the system it is necessary that the converter proper should be compound wound and that reactances should be inserted in the leads so that the rise in voltage can be obtained across these reactances instead of at the inverted converter. Frequently inverted converters are operated in parallel with alternators on the alternating-current side, and it is then as important to investigate the speed regulation of the prime mover driving the alternator as when contemplating running such alternators in multiple, since the inverted converter naturally runs at a uniform rate of rotation and therefore if the alternators to be run in parallel therewith are not run at a uniform rate of rotation, cross current will be caused and serious difficulties might arise.

Rotary converters—Although converters of a higher frequency than 25 cycles occasionally are used, in most cases, and particularly when the plant is intended for railway work, 25 cycles is chosen, and the discussion will, therefore, apply to them. Were it not that rotary converters sometimes cause trouble by hunting, there is hardly any doubt they would be used universally, even with the limitations in voltage control imposed by their use, instead of synchronous-motor or induction-motor direct-current generator sets. The question of hunting, however, is so serious that frequently it is good policy to introduce the complication of running two or three machines instead of one, even at the lower efficiency, to insure satisfactory service. Hunting is caused by many circumstances, one being that the rate of rotation of the prime mover is not uniform, another that converters are operated in the same network, but interlinked by lines of relatively high resistance, another that the converter has sluggish magnetic circuit so that it can not quickly respond to variations in impressed voltage, still another that the impressed voltage on the converter, for some outside reason, tends to fluctuate suddenly. The remedy for the first case of hunting is obviously to get the rate of rotation of the prime mover more uniform, which often is very difficult, particularly if the machines are already installed. (With the stipulations imposed upon the engine builders, this case of hunting is not now so serious, and does not exist when the generators are driven by turbines.) Another remedy which occasionally gives satisfactory results is to use one or more induction motors of considerable size on the same circuit, or even a small induction motor with large flywheel, the tendency of the induction motor being essentially to steady the frequency by its momentum. The other cause, that of considerable resistance losses between converters or generators and converters, has a tendency to set up hunting also, since, with a slight fluctuation in current, due to various causes, the voltages fluctuate also. This fluctuation in impressed voltage will react in the rotary converter, and if the magnetic circuit is not very sensitive causes a state of unstable equilibrium

which leads to hunting. It is obvious that if the electro-motive force supplied to the armature varies suddenly, the flux also must vary at the same rate to insure the same relative position of the armature and the field. If the magnetism lags behind, the armature must take a different position from what it would have otherwise, and thereby a pulsation in speed is set up and the rotary "hunts." It is, therefore, evident that the magnetic circuit should be as responsive as possible; in other words, all causes delaying change of magnetism should be eliminated. As a consequence, it is not best to use magnetic material of low ohmic resistance, such as steel, but a considerable part of the magnetic circuit is made of cast iron, which has high ohmic resistance, and damping devices are inserted, not in the path of the main flux—that is, in the poles—but midway between the poles. This damping device is only effective when the rotary hunts; that is, when there is an appreciable armature reaction which sets up currents to the circuit formed by the bridge. The last cases of hunting can be explained and remedied in much the same way as in the previous case, and sometimes preclude the use of converters in places where the rate of rotation might be uniform and where the ohmic losses between generators and converters might be small, the disturbing element being a fluctuating load placed near to the converter and therefore inducing periodic pulsations in voltage on the converter circuit.

Summarizing the hunting situation, we find that although there are a number of causes for this trouble, the phenomenon is fairly well understood and no great difficulties need be expected in well-planned 25-cycle systems. The other limitation of rotaries is the difficulty of obtaining wide range of voltage as compared with direct-current generators, and providing for automatic compounding over a wide range.

Although it is possible to compound rotary converters to some extent by merely using a series field similar to that on direct-current generators, the amount of compounding is very slight indeed, and is obtained by leading or lagging currents taken by the converter and passing over the very low reactance of the converter armature proper. In order to compound to any considerable extent, it is necessary to have some reactance in the circuit between converter and generator, and to permit the converter to take wattless currents at almost all loads. The proportion of wattless current and reactance can be varied considerably, and still the same results obtained, so, for instance, roughly speaking, 10 per cent compounding can be obtained by 50 per cent leading current and 20 per cent of reactance; or by 20 per cent leading current and 50 per cent reactance, etc. The more reactance over a certain limit, the more liability of an unstable operation and the more wattless current, the poorer the power factor at light loads, and the greater the armature heating; indeed, with quarter-phase or six-phase converters the saving in armature copper is not great over that in three-phase converters if too large a percentage of wattless current is used in phase control. A fair average is to insert about 15 per cent reactance. With such reactance in a circuit of six per cent resistance, it is possible to obtain constant potential at all loads with a power factor of 60 per cent at one-quarter load, 91.5 at three-quarter load, 100 per cent at full load, 99.5 at 50 per cent overload and 96.5 at double load, or even higher if the series field is so adjusted that the converter runs non-inductive at three-quarter load, then a power factor of 73.5 at one-quarter load, 97.5 at one-half load, 100 per cent at three-quarter load, 99.5 at full load, 98 per cent at 50 per cent overload and 96 per cent at double load. Under these conditions the voltage not only is approximately constant over the whole range of loads, but is still within a fraction of one per cent up to 50 per cent overload.

With several rotary converters operated in the same station, it is advisable to use independent transformers, or at least independent secondaries for each transformer, since, if this is not the case, considerable cross-currents are likely to flow if the direct-current brushes on each individual converter are not placed identically the same.

The transformers themselves should preferably be designed with the greatest amount of self-induction, since, as stated above, in almost every converter installation some reactance is advisable. Thus the essential difference between a transformer used for lighting and a transformer used for converter is that transformers for rotary converters have more self-induction and higher efficiency than lighting transformers, or at least that in the design of these transformers this condition has been looked for.

The great advantage of rotary converters over motor-generator sets is the higher efficiency, due to the small copper and iron losses, and the facts that only one machine is used instead of two or more, that the power factor can be 100 per cent at all loads, that they can act as condensers, and therefore compensate for lagging currents introduced by other apparatus on the system, that in case of a very heavy load they can give almost unlimited power, and that even as such shunt machines the voltage does not materially change with the load, but that it will at the most vary a few per cent between no load and full load, whereas the direct-current machine probably will vary perhaps 10 per cent or more under the same conditions.

The ratio between alternating and direct current electro-motive force of a converter or inverted converter depends upon the system used, upon the ratio of maximum to square root of mean square value of impressed electro-motive force (that is, the electro-motive force given by the generating apparatus), upon the load of the machine, upon the ohmic losses in the machine, upon the position of the direct-current brushes on the commutator, upon the excitation, upon the ratio of pole arc to pole pitch, and upon the operating conditions, that is, whether the machine is used to convert alternating to direct-current power or *vice versa*. Sixty-cycle converters, which usually have shorter pole arc and higher commutator losses than 25-cycle converters, have, as a rule, higher ratios, and when used as inverted converters, lower ratios than 25-cycle machines.

At no load, with an average wave shape such as given by standard generating apparatus, the average ratios are:

Percentage pole arc.....	67	74	80
Three-phase and six-phase double delta.....	62	61	60.5
Six-phase, diam. and two-phase	72.5	71.5	71

With the average losses at brushes and armature winding, this will give the following ratios at full load of a 550-volt converter:

Percentage pole arc.....	67	74	80
Three-phase and six-phase double delta	63	62	61.5
Six-phase diam. and two-phase	73.5	72.5	72
INVERTED CONVERTER.			
Percentage pole arc.....	67	74	80
Three-phase and six-phase double delta	61	60	59.5
Six-phase, diam. and two-phase	71.5	70.5	70

The values apply when the direct-current brushes are placed on the exact neutral point. If the brushes for some reason or other are placed either leading or trailing, these ratios are increased, that is, the direct-current voltage for a given impressed alternating-current voltage is less. This variation may amount to several per cent, therefore moving the brushes makes it possible to lower the di-

rect-current voltage, and thereby change the ratio to some extent without changing the transformer connections. It is, however, impossible to increase the direct-current voltage, no matter in what position the direct-current brushes are placed.

Changing the excitation will also change the ratio. With reduced excitation, that is, with lagging current, the ratio may increase a couple of per cent and with over-excitation it may drop a couple of per cent, depending upon the electrical constants of the machine.

Synchronous Motor-Driven Direct-Current Generators—These have the advantage over the rotary converters that they can be run on circuits of high voltage directly, without the use of step-down transformers, that the direct-current voltage is independent of fluctuations in voltage on the alternating-current side, and dependent only upon the speed control, and that by a mere chance of field excitation the direct-current voltage can be varied over a very wide range. Their limitation, however, is their tendency to hunt, which is quite as marked as with rotary converters. In other words, the limitations inherent to rotary converters exist also with synchronous motors and even to a greater extent, at least with synchronous motors wound for high voltages with relatively few slots, with which type it is decidedly more difficult to apply anti-hunting devices than with rotary converters, which, by their more distributed winding and large number of small slots, are less likely to have excessive eddy losses in the anti-hunting devices. It is, therefore, questionable whether it is advisable to substitute such sets for converters under any conditions, the more so as frequently the cost of a synchronous motor wound for very high voltage is not much less than the step-down transformers and a low-voltage motor.

Induction Motor-Driven Direct-Current Generators—This combination has decided advantages over the first mentioned types by its stability, and may, therefore, find considerable field of application in systems of unstable frequency and fluctuating voltage, or installations which already have a number of synchronous apparatus. As stated regarding rotary converters, it is sometimes possible to obtain good results with hunting converters by installing induction motors of considerable inertia on the same circuit, and such a set naturally lends itself very well for this purpose. At moderate voltages, up to, say, 2,000 to 3,000, induction motors can be built with good constants at a reasonable cost, and do not, therefore, involve the use of step-down transformers. At higher voltages, however, and particularly up around 10,000 volts, it is found that the use of step-down transformers not only introduces much better constants but frequently makes a cheaper installation. Under these conditions it is decidedly questionable whether it does not pay to install more line copper, remedy the speed control of the generators, or, in general, remove the causes prohibiting the use of rotary converters, since the cost of such motor-generator sets is much higher, and the contents much lower, than when converters are used.

Direct-Current Railway Motors—The characteristics of this type of motor are so well known that it is not worth while to discuss them further than to say that in general the tendency seems to have been during the last few years to design the motors for a given train weight and maximum speed, disregarding the number of stops, provided the car is accelerated and retarded at a comfortable rate, which involves, of course, the schedule speed changing with the number of stops.

To accomplish this, the motors are so designed and particularly the ventilating conditions are such that the temperature of the fields will not rise more than a safe number of degrees, if subjected to the accelerating current at the rate of, say, 10 times per mile, and the armature has such a low-core loss that it can run for a considerable time at the maximum speed. Such condition is made possible with the modern mechanical design which readily conducts the heat from the inside to the outside, and thereby obviates great differences in temperature. The main difference in electrical design is that much more precaution has to be taken to have low self-induction in commutation. This is necessary since, as stated above, the field winding has to stand the full current of acceleration for a much longer time than formerly was the practice, and therefore a less number of turns and a weaker field in general are used in modern motors, this condition causing sparking unless the armature reaction is reduced and the number of commutator segments increased. We therefore find now as a rule a higher flux and a greater number of commutator segments than in older types of motors.

Alternating-Current Railway Motors—A very superficial study will show that whenever this type of motor has been adopted the reason lies, not with the motors themselves, but in the fact that a lesser amount of feeder copper and possibly fewer attendants are required with an alternating-current railway system than with a direct-current system involving rotary converters. It is, however, only in cases of relatively long runs with few stops, or in mountainous roads where power can be returned by induction motors, that economy can be shown with this system as compared with the direct-current system. It is very doubtful whether in many cases where alternating motors have been installed, direct-current motors would not have been better engineering.

The alternating-current railway motors are of the polyphase induction type and therefore their characteristics are essentially those of direct-current shunt motors, that is, they run efficiently only at one speed, whereas the direct-current series motor will operate at high efficiency over a considerable range of speed. It is therefore obvious that in railway service where the speed for many reasons has to vary during the run and where cars are stopped and started at rather short intervals, the actual power taken by the induction motor will be greater than that taken by the direct-current motor. Since, furthermore, any induction motor must take a certain amount of wattless current, the apparent power input of the motor must be greater than with direct current. With the same mechanical clearance in the two types of motors, the amount of wattless current taken by the induction motor would be quite prohibitive, therefore these must be made with decidedly smaller air-gap than direct-current motors, which necessitates more careful adjustment, and involves more repair work. The wattless current is also dependent upon the voltage at which the motors are operated, and increases as the voltage increases. With the known methods of insulation and with the limited space available for railway motors, it seems that it is almost out of the question to consider a design at higher potential than 3,000 volts. Even with the smallest safe air-gap this will give a power factor of at the most 85 per cent or 88 per cent at full load under the best conditions, which with an efficiency of, say, 86 per cent, including gear loss, gives an apparent efficiency of at the most 77 per cent; in other words, the kilovolt ampere input of the motor would be about 30 per cent greater than that corresponding to the work done. Whereas with the direct-current motor the power input would probably not be more than 12 per cent or 15 per cent greater than that corresponding to the work done. Therefore, and in view

of the laws governing the design of such induction motors, it is to be expected that the copper losses in an alternating-current motor will be decidedly greater than in a direct-current motor. The core loss in the field of the induction motor is also greater than the core loss in the armature of the direct-current motor at maximum speed, so that this gives another source of increased heating of the motor. This increased heating is decidedly objectionable, as it involves the use of a much larger machine than the direct-current motor, which increases the cost and weight of the equipment. To illustrate this somewhat more concisely, consider the losses occurring in a couple of motors of direct and alternating-current type while accelerating from standstill up to full speed. The core loss and eddy losses in the direct-current motor are zero at standstill, and increase to a certain maximum at full speed. In the alternating-current motor at standstill, even under favorable conditions, the core loss in the field is the same as the maximum core loss in the armature of the direct-current machine, and the core loss in the armature at standstill about the same as in the field. At full speed the core loss in the field still remains the same, but the core loss in the armature is zero and therefore, roughly speaking, the core loss of the direct-current motor is in the neighborhood of half of the core loss at maximum speed, while accelerating, and is one and a half times as much in the alternating-current motor. In other words, during acceleration the alternating-current motors have three times as much core loss as the direct current. Adding to this loss the greater copper loss due to the larger power input of the motor, we find from actual calculations that the alternating-current motors of good design will have in the neighborhood of four times as much loss as the direct-current motors when operating over relatively short lines, as would be the case in rapid transit systems. To dissipate four times as much energy means that the volume of the motor has to be very much greater, and its heating facilities decidedly better. This does not mean that the actual heating will be as much more, since, at least in long-distance runs, the time of accelerating is short compared with the total time of the run, nevertheless the loss will be decidedly more and consequently it would seem as if the actual cost of the induction motor equipment per car would be from 50 per cent to double that of direct equipments, depending upon the service. Since the cost of the motor equipment is a very large factor in the installation of a plant, and since the direct-current equipment is so standardized and brought down to the least possible cost here in the United States, this is probably one of the main reasons why upon careful examination it has been found not only a saving of power but great economy in the first cost to install direct-current rotary converters instead of alternating-current systems. In places, however, where the direct-current railway system is not so fully developed, the difference in cost between the two systems might not be so much, and that accounts for some European concerns installing alternating-current motors.

Construction and Management of Electric Tramways in Switzerland.

Mr. J. Sigfried Edstrom has made a study of the details of the management of electric railways in Switzerland from which a few facts have been taken. Switzerland has 88 kilometres of railways and electric tramways per million of inhabitants, Germany 64.6 kilometres, Austria 25.6 kilometres, England only 19.6 kilometres. From the opening of the Vevey-Montreux electric line, which was undertaken in 1888, the number of new lines and electric tramways has not ceased to increase.

The following observations have been made regarding the means of communication: All the electric tramways are subject to the control of the federal department of railways and telegraphs. This department examines from the point of view of security each installation and the instructions for the installation of wire conductors are carried out rigorously.

The greater part of the central stations, especially those in small towns, have their generators driven by water power. In the large towns only water power is replaced by steam or gas engines. The steam engines are horizontal and of low speed. They are ordinarily of the compound type and are coupled directly to the generators, the transmission by belts having been almost entirely abandoned. Since the inauguration of a central tramway station at Zurich, in which for the first time steam engines were used, they have tended to expand more and more.

Feed cables for electric tramways are in many localities. These are installed underground in conduits built of sandstone. In the suburbs the feeder cables consist for the most part of uninsulated wires supported by poles. It is the same in the large towns, and in the busy as well as in the residential streets. The current is received by different systems of trolley connections, all of which have return contacts by means of the rails. The trolley wires are of copper eight millimetres in diameter, and supported either by fixtures placed on the houses or by iron poles. The fixtures on the houses are placed there by paying from 50 to 150 francs to the proprietors of the houses. Conductors placed at a height of six millimetres above the ground should be able to resist without breaking, and this at a temperature of 20 degrees centigrade, and at a strain which is five times greater than that to which they are ordinarily submitted. The highest pressure permitted is 600 volts in the towns and 750 volts in the country. Regarding the difference of potential between the rails and the earth there does not exist any special rule. Nevertheless they try to make the joints of the rails good conductors, and the return wires are also good conductors, so that a very small resistance is obtained. At Zurich the rails are soldered together.

In order to protect those passing from the telephone wires coming in contact with the tramway wires above ground the authorities who are charged with the control make it compulsory to use a large steel wire placed above the electric conductor. This protecting wire is fastened to the rails by a coupling wire eight millimetres in diameter. Protecting wires which begin at the earth also are only authorized where all the telephone wires are completely surrounded. In case of the construction of a new tramway the telephone wires are laid at the expense of the tramway company, and for the telephone wires such a route is selected that the lines are increased in number only at points where protecting wires are installed.

In the towns they ordinarily use rails of from 40 to 50 kilogrammes weight per metre. In the country more often rails which weigh 20 kilogrammes per metre are used. In Geneva all the rails are placed on a bed of concrete with a section 26 by 30 centimetres. At Zurich the rails are placed on a bed of concrete which occupies larger space than that upon which the line is to be placed. Curves are permitted with as small radius as 15 metres.

The cars are generally in two parts. They can carry from 14 to 20 passengers inside and from 9 to 13 outside. Each car has two motors of 20 horse-power. Many lines which were built some time ago still use cars provided with motors which are regulated by means of a resistance. Where alternating-current motors are used the speed is generally governed by the insertion of a resistance in the induction motor. The car houses are very large and can be heated in winter, and the cars are there submitted to careful inspection. Near them are often found a repair shop and bath house which is used by the employés, also special provisions for the drying of the clothing of the motormen.

THE INDUCTION MOTOR AND THE ROTARY CONVERTER AND THEIR RELATION TO THE TRANSMISSION SYSTEM—II.

(Concluded.)

BY CHARLES F. SCOTT.

SUMMARY.

1. The motor is an *active* element in the system; it acts as a generator in impressing its own wave form, its electro-motive force and its fluctuations upon the circuit. These fluctuations may be caused by an intermittent load.	1. The motor is a *passive* element in the system. Each motor attends to its own work and does not try to run the system.
2. The motor is a sensitive element in the system. Its successful operation is dependent upon a proper relation between the design of the motor itself and of other machines connected with the system. Its successful operation also depends upon the proper adjustment and freedom from speed fluctuation in generators and other motors. It is liable to momentary variations from normal conditions, such as a sudden over load and sudden increase of generator speed or a momentary fall in electro-motive force.	2. The motor is not sensitive to differences in the design of other apparatus operating on the same system.
3. The motor requires skill and care on the part of the attendant for starting, for readjusting and for keeping the various brushes and auxiliary apparatus in proper condition.	3. No experience and electrical skill are required of the attendant, and there is little or nothing to get out of order either through carelessness or design.
4. The power factor is under the control of the operator and the current may be made leading or lagging. Instruments are necessary in order that proper adjustments may be made by the attendant.	4. The motor has a definite power factor, depending upon the load; the out-of-phase current does not vary greatly at different loads. The changing load, therefore, has comparatively little effect upon the drop in voltage and in regular service there is little liability that the motor will disturb the electro-motive force of the circuit.
5. The motor and its operation are complex and involve many possibilities of accident.	5. The motor and its operation are simple and reliable.

The synchronous motor is obviously not suitable for general distribution of power, owing particularly to its lack of starting torque, the skill required in attendance and the liability of the motor to stop if the conditions become abnormal. These objectionable features, however, are of much less importance when motors are installed in substations or are of sufficiently large size to justify an attendant.

The characteristic of the synchronous motor, which may be particularly advantageous, is the fact that the power factor of the current can be varied and that the current may be made leading. In this way the current required and the drop in the generator and transmission circuit may be reduced. If the motor is used on a circuit supplying induction motors the synchronous motor may be given a leading current, thus neutralizing the lagging current to other motors. The extra current taken by the synchronous motor for this compensation necessitates a larger size than would otherwise be required.

The characteristic of the induction motor which is usually regarded as most unfavorable in comparison with the synchronous motor is the fact that its current is always a lagging current. In a comparison with synchronous motors only large sizes should be included, as synchronous motors of small size are not to be seriously considered in practical work. The induction motors of large size have relatively high power factors; *i. e.*, the out-of-phase current is small. Moreover, this current is definite in kind and nearly constant for different loads, so that it is a definite and constant element which may be provided for. It may, therefore, create less disturbance on the system than the out-of-phase current of the synchronous motor, which is either lagging or leading, large or small, depending upon the intelligence and care of the attendant and upon other conditions. In one case the voltage of the system is under the control of the attendant in the power-house and the lagging current to induction motors which are running with either constant or varying load is practically constant. On the other hand, when synchronous motors are used, the voltage of the system is dependent upon all the motors, and uncertain or disastrous results are liable to be caused by adjustments by the various motor attendants. In many cases it is far better to provide the generators and circuits suitable for supplying the lagging current required by induction motors, rather than to attempt to gain the theoretical advantages attending the use of synchronous motors, as the securing of these advantages requires that so many conditions be favorable. At best, the synchronous motor is less satisfactory to operate and is far more sensitive to abnormal or emergency conditions than the induction motor.

The foregoing considerations will indicate why it is that the induction motor has taken such a leading place, while the synchronous motor has been less favored and is now rarely considered seriously as a competitor of the induction motor except in large sizes.

II.—THE ROTARY CONVERTER.

The rotary converter is in its relation to the transmission system essentially a synchronous motor. The foregoing characteristics of the synchronous motor, except those which involve a load upon the motor, apply also to the rotary converter. The starting, however, is somewhat simpler, as there is no load to accelerate except the armature. No separate exciter is necessary, as the converter can furnish its own direct current for exciting. A converter may be compound wound so that as it is loaded the increased excitation changes the out-of-phase current in such a way as to compound the voltage, thus overcoming the drop which would otherwise occur in generator and transmission circuits; whereas, the synchronous motor would cause a falling off in voltage. The rotary converter is usually used in units of considerable size placed in substations having skilled attendants. For these reasons the operation of rotary converters does not involve so many difficulties as that of synchronous motors.

Direct current is obtained from alternating circuits, either by the rotary converter or a motor-generator, in which either a synchronous or an induction motor is employed.

The rotary converter has the advantage over the motor-generator in point of cost, there being but one machine instead of two, in point of efficiency, there being the loss in one machine instead of two, and in its effect upon the voltage of the transmission system, as it may be compounded to overcome the drop which would otherwise occur in generator and transmission circuit. On the other hand, the electro-motive force of the direct current delivered by the converter depends upon the electro-motive force received; whereas, the electro-motive force of a motor-driven generator is independent of the electro-motive force of the

supply circuit, and may be adjusted or compounded as may be desired. It is found in practice, however, that the voltage delivered by a rotary converter can be satisfactorily adjusted and controlled by regulating devices or by compounding so that usually the close relation between the electro-motive forces at the two ends of the converter is not disadvantageous, provided the electro-motive force of the supply circuit is reasonably constant.

This statement applies to those cases in which practically constant voltage is desired. There are, of course, special cases in which the voltage is to be adjusted over a very wide range or where for other reasons the motor-generator is to be preferred.

A motor-generator employing a synchronous motor does not seem to possess any essential advantage over the converter except in some cases where the independent control of the direct-current voltage is desired. The use of the synchronous motor does not remove the objections to the rotary converter, which are based on the fact that it is a synchronous machine.

A motor-generator employing an induction motor has the advantage of employing induction instead of synchronous apparatus, thereby securing many of the advantages set forth in the comparison between synchronous and induction motors. Circuits which are supplied by generators in which the speed has a rapid and periodic fluctuation, or in which for any other reason the use of a synchronous machine is impracticable or undesirable, may nevertheless operate an induction motor driving a generator with full satisfaction. The various characteristics of the induction motor under emergency conditions, such as sudden overload, momentary interruption or lowering of the voltage of the supply circuit, may cause little or no inconvenience if the induction motor is used, whereas, it might cause serious interruption to a rotary converter or a synchronously driven generator. The induction motor driving a generator is also to be preferred where units are quite small and the attendance is unskilled. The rotary converter, like the synchronous motor, is unsuited for general distribution in small units.

The foregoing statements and comparisons involving the rotary converter doubtless comprise the principal reasons why this apparatus is being so widely adapted and is in such general use. To indicate the wide use of this apparatus it may be stated that the Westinghouse Electric and Manufacturing Company, with which I am connected, has sold over 400 rotary converters. Of this number 30 per cent are for a frequency of 60 cycles or more. The aggregate output is over 165,000 kilowatts.

Most of this apparatus is now installed and is in successful operation. In fact, the difficulties in connection with the installing and operation of rotary converters on circuits which are suited for them are trival and do not materially differ in amount from those which may be expected to occur in connection with other kinds of apparatus.

The very wide use of the induction motor and the rotary converter is an established fact, and it is believed that many of the reasons for their selection in preference to other kinds of apparatus have been set forth in the foregoing notes.

III.—THE ALTERNATOR.

Many of the specific relations between the induction motor and the rotary converter and the supply system have been indicated. There is obviously a close relation between the alternator and the apparatus which it supplies. The conditions are radically different from those involved in incandescent lighting. An alternator which may be quite satisfactory for lighting purposes may be highly inadequate for successfully supplying current for either induction motors or rotary converters.

For supplying current to induction motors an alternator should have good inherent regulation. The lagging current taken by induction motors requires a greater increase in field current for maintaining a given voltage than is required when the load is non-inductive. In order that the field current may be excessive, the generator should be properly proportioned to have close regulation. The adjustment of the field current by external devices is not a wholly satisfactory substitute for close inherent regulation. Suddenly changing loads or to the throwing on or off of motors causes fluctuations in voltage, as the external devices can not act quickly enough to prevent the disturbance. The necessity of good inherent regulation is all the more necessary where the motors are large in proportion to the size of the generator and where loads are fluctuating.

For the operation of rotary converters the generator speed should be uniform. Engines which are sufficiently uniform in angular velocity to enable generators to run successfully in multiple may nevertheless be unsuited for operating rotary converters or synchronous motors. It is preferable also that generators for operating rotary converters should have good inherent regulation, not only in order that the electro-motive force may be maintained at heavy loads, but also for the purpose of holding the converter rigidly in synchronism. If the alternating field is comparatively weak, as is usual in poorly regulating machines, there may be a shifting of the magnetic field back and forth with different armature currents, quite similar to the shifting of lead in direct-current machines. It is obvious that if the effective position of the field poles may shift back and forth, that this shifting is comparable with fluctuations in generator speed, and becomes a source of unsteadiness in the system which may contribute to the "hunting" of rotary converters. This shifting may occur also in a machine having a strong field if a large proportion of the magnetizing force is absorbed in the iron of the field magnet, *i. e.*, a machine with a saturated field. Such a machine may have good electro-motive-force regulation, and still be of an inferior type for the driving of synchronous machinery.

It follows, therefore, that a generator which is to supply induction motors or rotary converters, should be selected with reference to the service which it is to supply. In some cases unsatisfactory results have been obtained in the use of motors or converters, duplicates of those which have given full satisfaction elsewhere. The trouble has been located in fluctuating speed or in the characteristics of the alternator supplying the current.

A transmission system must be considered as a unit and the inter-relation between the alternator and the apparatus to which it supplies power must be fully considered.

The theoretical arguments which are occasionally urged against the alternating system, the induction motor and the rotary converter, find their most effective answer in the plants which are now in operation and in their record of service.

The induction motor and the rotary converter to-day represent the survival of the fittest, and confirm the judgment of those engineers who have consistently and persistently advocated their use.

Consul Warner, of Leipzig, notes that a recently patented insulating material is made by taking pulverized casein and mixing it with vegetable oils. The mixture, to which rubber, caoutchouc, resin or coloring matter may be added, is pressed into forms and dried, or vulcanized by the addition of sulphur.

Science Brevities

Conduction of Electricity through Metals—A brief account is contributed by Herr Riecke to the *Physikalische Zeitschrift* of an experiment conducted by him to determine whether positive metallic ions play a part in the phenomena of the conduction of electricity through metals. The apparatus used consisted of three equal cylinders, two of copper and the third of aluminum, the latter being placed between the two copper cylinders. The whole system thus constituted was inserted in the charging circuit of a storage battery for a year. During this time 958 ampere-hours passed through the cylinders. In an electrolytic cell they would have caused the deposition of 1.14 kilogrammes of copper. Careful determinations of the weights of the single parts at the beginning and at the end of the year, however, showed no variation of the weights, whence the conclusion is arrived at that movable positive metallic ions play no part in the conduction of electricity through metals. .

Structure of Spectra — It has been shown in a masterly paper by W. Sutherland, in the *Philosophical Magazine,* September, 1901, that the atoms of the different elements are all equipped with the same, or nearly the same, electrical apparatus, whereby the mechanical energy of the atom is made communicable to the ether for radiation. The atom, with the kinetic energy assigned to it in the kinetic theory of matter, exercises no direct mechanical effect on the ether, but is like a flywheel driving the dynamo, to which we may liken the electrical equipment of the atom. The structure of spectra is traced to the two facts, first, that atoms vibrate as deformable, but practically incompressible, bodies of finite calculable rigidity, so that their surfaces have stationary waves corresponding to the fundamental mode of vibration and its harmonics, and, second, that electrons in describing nearly circular orbits around an atom, out of an infinity of such orbits possible, have orbits of certain frequencies made predominant by resonance. An electron can make 1, 2, 3 . . . m revolutions between two occasions when it gets its energy renewed by striking the atom at the middle of one of its vibrating internodes, or it can make $1 + \mu$, $2 + \mu$ . . . . $m + \mu$, where μ is generally an harmonic fraction. The orbits for a positive electron are different from those for a negative, and, therefore, a relative motion between positive and negative electrons is set up. This is the direct cause of the vibrations of light. This relative motion can be represented by giving the positive and negative electron different angular velocities round the circumference of a circle. By such motions Balmer's and Rydberg's formulæ can be explained, and Rydberg's laws lead to the conclusion that the fundamental angular velocity of all electrons associated with all atoms is a constant representing a frequency of 33×10^{14} per second. From the rigidities of the metals at absolute zero the mechanical periods of vibration of the atoms are calculated and proved to exhibit simple harmonic relations, and probably to possess a common harmonic of a frequency of the same order as that of ordinary light. It is probable that the common harmonic of the atoms and the fundamental mode of motion of the electron are identical or harmonically related. The spectra of different elements thus appear to be caused by practically one and the same form of electrical appliance (pair of electrons) which is supplied with energy by the atom at various internodes. One spectrum is only a slight kinematical variation of another. The principles of the kinetic theory of gases and of the electromagnetic theory of light are brought into natural relation. Rigidities at absolute zero, calculated according to the kinetic theory of solids, are shown to be connected with the structure of spectra, and molecular resonance is shown to play a striking part in the melting of the metals. The atoms in a compound molecule are more intimately united than is usually supposed.

Energy of Three-Phase Motors — Mr. Stern, in an article contributed to a recent issue of the *Elektrotechnische Zeitschrift,* discusses two methods of measuring the energy of three-phase motors—*viz.,* the "zero-point method" and the "three-wire method"—and gives calculations based on a series of measurements to show that both methods are very inaccurate, wherefore he concludes the construction of meters or wattmeters should not be based upon them.

New Physiological Photometer — Mr. G. M. Stanorevitch has described a novel kind of photometer which has the great advantage of extreme simplicity, in *Comptes Rendus,* August 5, 1901. It is based upon the fact that a certain quantity of luminous energy is required to produce a visual impression upon the retina. Thus a triangular or circular patch, to be distinctly visible, requires a certain constant minimum illumination. This minimum differs with different eyes, and with different conditions of the same eye, but is, on the whole, constant within, say, 10 per cent. The author's photometer has the form of a small telescope, 10 inches long and 2 inches in diameter. At one end is a piece of ground glass which is turned toward the source. Some four centimetres behind it is fixed an iris diaphragm, whose aperture is at the principal focus of a convex lens. The latter produces a parallel beam of rays which illuminates another diaphragm, and the latter again is observed through another lens. In using the instrument the iris diaphragm is screwed down until nothing is seen, and then gradually opened until the round aperture is clearly defined. The instrument is calibrated empirically. It has the advantage of not depending upon the calmness of the atmosphere, and it is also very portable. A number of luminosity determinations may be made in the streets in a single evening. But care must be taken to have the eye in the same state of fatigue.

The Electrolytic Cleansing of Metallic Surfaces—The following is a translation made by the London *Electrical Engineer* of an article by M. F. Loppé, which appeared some time ago in a French technical paper: In ordinary practice metallic surfaces are cleansed by immersion in either alkaline or acid solutions. Acid solutions are employed for cleansing the surface of iron, copper and alloys of copper, while alkaline solutions are used to clean aluminum or zinc. These methods of cleaning metallic surfaces by simple immersion are lengthy and costly; the solutions used gradually become saturated with metal and lose their cleansing power; and if, as in the case of copper, the metal dissolved in the cleansing process is valuable, it is necessary to recover it from solution, a recovery which is not always easily carried out. Moreover, the liquids employed are corrosive, and, therefore, if their action is not carefully checked, the metal surfaces may be damaged, or the workpeople may be affected by their corrosive or poisonous nature, while, finally, there is often considerable difficulty in getting rid of the waste pickling solutions owing to local regulations concerning drain and water contamination. Attempts have been made to overcome some one or more of the above-mentioned difficulties by employing electrolytic methods of cleaning, such as that used by Cowper-Coles. These methods have been applied to the cleaning of iron surfaces, such as

boiler tubes, etc., but the employment of an acid solution has always been advocated. Recently, however, the Vereinigte Electrizitäts Aktiengesellschaft, of Vienna and Budapest, have patented a process for the electrolytic cleansing of metallic surfaces which has yielded remarkably satisfactory results, both from the point of view of rapidity and of economy. This new process may be applied to any kind of metallic surface, and the cleansing solutions employed do not become deteriorated in their properties by use. Any metal removed from the surfaces which are under treatment may be readily recovered if the value of the metal renders such recovery desirable, and, further, the solution being neutral and practically harmless, it may, when necessary, be run off into the drains, etc., without creating a nuisance. The electrolyte used consists of an aqueous solution of an alkaline salt, and one of the electrodes is formed of the metal whose surface it is desired to clean, while the other is formed of carbon or of some metal which is not acted upon by the solution (or, as will be pointed out later, both electrodes may consist of the metal whose surface is under treatment). In the case of iron or copper, or alloys of copper, the metal surface is made the anode, and the metallic oxide which is dissolved from the anodes is reprecipitated from the solution by the alkali which is generated at the cathode. The electrolyte is thus continuously regenerated. When it is wished to clean zinc and aluminum surfaces, these metals are employed as the cathodes, and alkaline aluminates and zincates are formed, from which, however, the zinc and aluminum oxides are subsequently precipitated by the acid liberated at the anode. This form of electrolytic cleansing process may, moreover, also be used for the cleaning of metallic surfaces from greasy and fatty matters, and for this purpose the metal must always be used as the cathode, the alkaline hydrate liberated at this electrode saponifying and dissolving the grease on the metallic surface. If it is wished to use the process for the preparation of iron plates, etc., which are to be subsequently tinned or electrogalvanized, it is carried out as follows: The electrolyte employed consists of an aqueous solution containing 20 per cent of sodium sulphate, such as is produced as a waste product in some factories, and both of the electrodes are formed of the iron whose surface is to be cleaned. The current is first of all passed in one direction during a certain period, and the plates acting as anodes are cleaned of metallic oxide by the acid set free at their surface, while the plates acting as cathodes are cleansed from grease by the alkali. The anode plates are then removed and replaced by fresh uncleaned plates, and the current is then reversed so that the plates which were previously cleansed from grease as cathodes in the first operation are now cleansed from oxide as anodes, and the freshly introduced plates now acting as cathodes are in their turn freed from grease. When this operation is completed, the current is again stopped, and the anode plates are replaced by fresh plates, and the current is once more started in the reverse direction. The process is then continued in this way, the plates being successively cathodes and cleansed from grease and then anodes and then cleansed from oxide, and are finally removed from the cleaning vats. The duration of the process naturally depends upon the current density employed. With a current of 60 to 120 amperes per square metre—*i. e.*, rather under 6 to 12 amperes per square foot—of the metallic surface, each operation lasts about half an hour, and as each surface undergoes a double treatment, first as cathode and then as anode, the complete treatment requires from 60 to 120 ampere-hours per square metre of surface. The mean voltage required is about four volts, and the energy required per square metre of surface cleaned is, therefore, from 240 to 480 watt-hours, which is a very small expenditure. When the articles cleaned are iron plates they are slipped into frames made of lead-covered iron wire, which are not attacked by the solution. The space inside the frames is about two centimetres wide, and the sheets are slipped in either through an opening at the top or at the side, and are so adjusted that they come into contact with the frames at several points, thus obtaining a good electric contact. The frames are arranged parallel to each other, but are insulated from one another by wood separators. At one side of the vat the alternate frames are connected together to one conductor, while the intermediate ones forming the second electrode are connected together to the other conductor. The electrolytic vats are usually made of concrete, and the whole of the frames can be lifted from the vats together in order to remove and replace the plates. When the current is passed there is a considerable evolution of gas, and the solution becomes turbid. The solution also becomes heated, and a flocculent precipitate of the reddish-brown ferric hydrate is formed, which partly falls to the bottom of the vats and partly floats at the surface. The electrolyte is circulated by a pump, which forces it through a filter, from whence it returns to the vat. Each vat requires a voltage of about four volts, but if a higher voltage is available several vats may be arranged in series with advantage. The process has been employed at the large plate factory at Teplitz, in Bohemia, and a still larger installation is now being erected.

Value of Rœntgen Rays in War—The surgeon-radiographer to the Imperial Yeomanry Hospital, Mr. J. Hall-Edwards, described some of his experiences as to the value of Rœntgen rays in warfare at the recent meeting of the British Medical Association. He found that the plan of obtaining the current for charging the accumulators from a dynamo connected with a belt to a foot motor of the bicycle type was altogether impracticable, as no one could work the bicycle arrangement long enough to be of much use. A small oil engine was used instead of the foot power, and worked very satisfactorily. As to the results of the introduction of Rœntgen rays into military surgery, Mr. Hall-Edwards remarks: "With the friendly aid of these rays, we are enabled to record the effects of small-bore projectiles under the various conditions which occur in actual warfare. We are enabled to localize the position of a bullet or other foreign body with absolutely scientific accuracy; and, if our present knowledge be used to its fullest extent, we can see the condition of the parts as plainly as we could do were the soft tissues composed only of transparent gelatin. These facts being recognized, it is easy to see that the application of the rays to military surgery must produce results of the greatest possible value for future guidance, and that their complete application in a great war—such as we are at present engaged in —must prove of inestimable service in increasing our knowledge upon this most important subject. Many of the time-worn, useless and dangerous methods of finding the whereabouts of hidden bullets may now be forgotten; for with these rays we have at our disposal an aseptic, scientific and absolutely accurate method of localization, which may be improved, but which even now is as near perfection as our present knowledge can make it. There can be little doubt that, in the face of the new facts brought to light by means of these rays, military surgery will have to be rewritten, and the advance made will mark an epoch in its progress."

Manufacture of Glass—It is said that the method of fusing the materials on a hearth by electricity is giving very promising results. The sand, cullet and other substances are fed on to the hearth continuously by an archimedean screw, and the arc is produced by a direct current of 50 volts, but an alternating current can also be used. Considering the low voltage used, the fusion should be very economical, and especially so when the dynamos are water-driven.

The Delany Rapid Telegraph.

The ordinary perforating instrument for a machine telegraph has three keys, one of which makes in a paper ribbon a hole which allows an electrical impulse to be transmitted over a line and to appear at the distant end as a dot on the recording tape; another key makes a hole for a dash record, while the third merely pulls the tape along to show clear space between the characters.

It is of considerable advantage if two holes instead of one be made for each dot or each dash as is done in the Wheatstone system, and, previous to Mr. P. B. Delany's invention, this was done with the use of three keys, requiring a sharp blow from mallets in hands of the operators.

In the Delany exhibit at the Pan-American Exposition a tape having two holes for each character—*i. e.*, for each dot and for each dash—is made by the movement of one lever; that is, by the use of an ordinary Morse key, and this seems likely to revolutionize telegraphic practice.

The manipulator may be a foot away from the perforating apparatus, or he may be 1,000 miles. He may transmit over a simplex, duplex or quadruplex system. Wherever telegraphic transmission ends in a sounder there is a single lever moving up and down, and any single lever moving up and down may be made to punch a double line of holes in a paper tape.

As the key is depressed it makes a hole on the near or "marking" edge of the tape, as it is uplifted a perforation appears on the outer or "spacing" edge. If the key be held down for a dash then there is a corresponding interval between the inner and outer holes forming the dash, if it be immediately lifted the interval is shorter, forming a dot. The paper being pulled by a motor, spaces occur whenever the key is not in motion; and so an operator, sending to the perforator in good, rythmical "Morse," may record perforations at the rate of 35 words per minute as handily as you please, or a way branch, or a suburban station, or a neighboring city office, may send to a relaying office and "make a tape."

Having this tape, the receiving telegraph station may, if it chooses, use the record for manual transmission or by machine.

By arranging two contact fingers in such a way that when one of them brushes against the line it will connect the positive pole of an electric power, and when the other is contacted to line a negative impulse will be given, the perforations will serve to actuate the tongue of a polar relay. If the marking perforation originally made by the downward motion of the key passes under one of the contact fingers and allows connection to line, the relay tongue may be made to throw down the lever of a sounder in a local circuit, and this sounder lever will stay down until it is released by the passage of the spacing perforation which makes a contact with the finger carrying an opposite polarity; and the length of the character will depend upon the interval between the reversing holes.

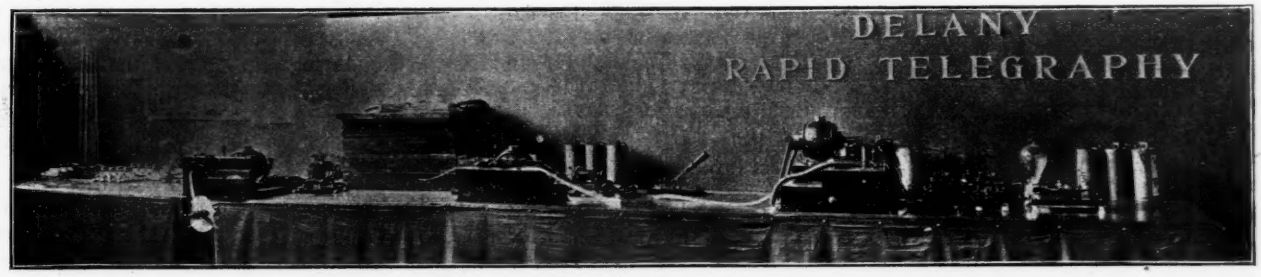
By this method the tape sends to a sounder a reproduction of the dots and dashes first made by the hand of the sending operator; and by substituting for the sounder the perforating transmitter in a local circuit a second tape may be produced at the distant end of the second relaying circuit; and at double or treble the speed of the initial hand sending. Reproduction may be indefinitely carried on, and in this way an automatic repeater is made which is much superior to the ones now in use, and that one section of line is in no way impeded by any disturbance on another section.

The final tape may be read by sight and translated into pen writing or typewriting, or it may be sent through a local transmitter at any speed that may suit the operator and so transcribed from sound.

Again, the first or second, or any reproduced tape, may be recorded on a receiving ribbon chemically treated at a rate of speed equivalent to instantaneous transmission or thousands of words per minute, and from that tape transcribed by typewriter. Summing up, there may be had from the initial perforations:

1. Manual transmissions from sight.
2. Morse transmission by machine for sound transcription at double or treble the initial speed.
3. Indefinite reproduction, or an automatic relaying.
4. Chemical reproduction at speeds unlimited.

A laboratory test of Mr. Delany's system has developed a transmission at the rate of 8,000 words per minute and recorded on chemical tape. The chemical telegraph devised by Mr. Delany starts into motion, both at the transmitting and receiving station, at the will of the sender; and stops automatically when the transmitting tape runs out. It is easy to look forward to the time when the telegraph will take the place, for general correspondence, of the mail train.



Complete Set of Delany Apparatus, as Installed at the Pan-American Exposition.

The illustration shows a complete set of the Delany apparatus, as installed at the Pan-American Exposition, beginning with the perforator on the right, after which comes the transmitter and receiver, the box between the two latter being the artificial lines used for demonstration of the operation.

Water Power in Canada.

A large water-power scheme is to be brought before the provincial parliament at Toronto, Ontario. Its aim is to develop the water power northwest of the town of Port Arthur, Ontario. The capitalists behind the scheme estimate that on the completion of the Canadian Northern Railway, Port Arthur will become a great flour-milling centre. It is proposed, therefore, to purchase land for a canal 22 miles long to connect with and divert the Keministikuia River. There is said to be an easy route between the high levels to a point three and one-half miles north of Port Arthur, where the syndicate proposes constructing a reservoir with an area of 1,500 acres. When the route has been secured it is not expected that much influence will be required to insure the water power of the river in West Algoma being conceded by the Ontario government to a company.

THE INSULATION OF CABLES.

Mr. Mervyn O'Gorman, at a meeting in March of the Institution of Electrical Engineers, London, presented a paper on the "Insulation of Cables." It was quite a lengthy discussion of this important question, and was abstracted by our London namesake, from which we publish the following:

In a cable factory materials cost from 10 to 18 times as much as the labor expended upon them. A factory with 150 skilled and 150 unskilled hands can turn over £300,000 worth of goods in a year; *i. e.*, £2,000 per skilled man, without complex machinery; it is therefore essential to buy with the utmost discretion, and to study the materials.

The cost of cables is the determining element in deciding for alternate or for direct currents, two-phase or three-phase working, high voltage or low voltage. In the case of a large low-tension cable conveying, say, 1,000 kilowatts, when the dielectric has become valueless after an interval which may, on the ordinary allowances for deterioration, be fixed at 30 years, the value of the copper remains unaltered, say, up to 70 per cent of the value of the cable (supposed drawn into a duct). In the case of such a high tension as 10,000 volts, however, should the cable become worthless, the amount of copper in it is too small to be reclaimed, and at the end of 30 years' life, a low-tension cable is worth 50 per cent more than its rival. A high-tension cable, though a riskier thing to make than a low-tension one, is more profitable and a better advertisement.

Price lists still provide somewhat misleading schedules which show an increase of about 20 per cent in price to correspond with a large though almost useless gain in the measured megohms per mile; whereas, whatever superiority there may be in a dearer quality of rubber, for example, is entirely dependent on the good faith of the maker, and is usually unverified by the purchaser, however scrupulously he exacts his extra megohms. Those who are ignorant on the subject must rely on the well-established maker's reputation to the detriment of new firms, however good their product and however cheap.

Searchers after cheapness turn their attention naturally to the dielectric, which was six times the price of copper, and their quest proceeded in four steps:

1. The degrading of rubber with chalk, etc. (sometimes to excess), and vulcanizing it.

2. The employment of metallic tubes, at first rigid and later flexible, these being generally lead tubes, containing cotton, jute, oiled paper, etc.

3. The rigorous search for water-proof oils, gums, asphalts, celluloid, bitumen.

4. Discarding flexible dielectrics in favor of bare copper supported in conduits.

Process 1 is a move in the right direction; but when too much loading is given to any rubber the latter gives way before very long, as is well known in the case of cheap garden hose. If such an excess as this is not reached, there is still danger that the rubber may fail to envelop the particles.

The relative prices of rubber and of such hygroscopic materials are somewhat as follows:

	Per Ton.
Para rubber	£400
Congo rubber (balls)	300
Celluloid	200
Amber grease, M. P., 105 degrees Fahrenheit	26
Hard grease, M. P., 114 to 116 degrees Fahrenheit	33
Refined special cotton oil	16.25
Oxidized cotton oil (nearly solid)	26
Thick resin oil	11.25
Ordinary resin oil	6
Resin	6
Mineral oil	4.5
Pitch	from £40 to 2.25
Stearine Pitch (flexible)	5.15

Hydrocarbons other than rubber are mostly supported on fibrous bases, which themselves vary largely in price, and have different advantages dependent upon their cellular structure. Thus:

	Per Lb.
Good cotton (Egyptian) free from sheive	7d.
Good linen yarn, unbleached	7d.
Fine manilla paper	5d.
Good fine jute, free from dirt and sheive	3d.
Wood paper	1¾d.

As regards permanency, the best materials are unsized manilla paper and fine jute. Certain dielectrics, excellent in other respects, in the course of a year develop crystalline structure, and the insulator, when bent, falls to powder. This is a common and more dangerous defect than is generally realized, and is often in evidence when such a cable is withdrawn from one site and laid in another.

High megohms per mile of cable are important only in feeders to facilitate fault finding, and unimportant in distributor cables and house wires, where there are many terminals. The number of probable terminals per mile of distributor, of "points" per mile of house wire, settles the useful insulation by giving a measure of the weakest part of the circuit. If the allowable leakage at any exposed point, say on a porcelain block, is 10 megohms, the leakage to be allowed on the cable connecting these points might be about 10 megohms also; we are thus led to tolerate in practice a cable test of, say, one megohm per mile for house wires and distributors. Such wires are quite satisfactory when a consumer's premises are supplied by a separate transformer. Ten times this might be required when the supply comes from a low-tension network; but even there the network need not be so good when there are only small local networks supplied by small substations not interconnected. The advantage of getting such a low test admitted is that it throws up to research, and later, perhaps, to practical use, a large number of otherwise impossible substances, such as celluloid, low-grade acid-free pitch, clay, perhaps even some such chemical treatment as case-hardening on iron conductors, rust, oxide, aluminum conductors, etc. A further advantage of low tension is that it diminishes the probability of high oscillating pressures when metallic switches are opened.

Experience proves that sufficient security is obtained with comparatively few megohms; large cables, say nineteen-sixteenths, having 50,000 megohms per mile, are now unheard of.

As the price depends upon overall diameter to an extent not usually realized, every effort must be made to find substances of which very thin films give a high puncture resistance.

Although there is a prevalent idea that cables give lower tests under high pressures, there is some doubt as to the truth of this. It would seem that the lower tests are due to increased leakages at the ends, for experiments on certain dielectric liquids have shown that they obey Ohm's law, and that their specific resistances within certain limits do not vary with the electro-motive force, nor with the area of the opposed electrodes. A high electromotive force is usually in testing, however, by tending to decompose with sufficient rapidity for detection any water in the dielectric which might escape notice with lower voltage.

Research reveals a surprising fact about our high-tension cables, namely, the large thickness of dielectric required, compared with the actual strength of the materials employed. A single strip of pure, dry manilla paper, weighing 70 grammes per square metre, and about 0.003 inch thick, when tightly wrapped on a length of small wire and tightly lead-covered, will resist 1,000 volts maximum; four such papers, impregnated with resin and resin

oil, will sometimes resist as much as 12,000 alternating volts on a length of cable; and yet 20 such papers, making a thickness of 0.06 inch (an ordinary low-tension radial depth), can not, by any means, be expected to withstand 50,000 volts on great lengths, though on a yard length of seven-sixteenths, say, they frequently will. A suggested reason for the superior strength of the short piece is that in a 100-yard length the probability of a streak of dirt or moisture, or of metallic particles, or of the oil having been crushed out of the paper in bending the cable, or of a bubble or vacuous space, or of an irregularity in the dielectric capacity, is 100 times greater than in the one-yard length. Indeed, except to verify the mechanical effect of severe bending, any high-pressure test or a *short* length of cable proves nothing whatever about the bulk. Similarly, a test for disruptive strength on small thickness proves nothing about a large thickness of the same material, because a diminishing dielectric strength with increasing thickness is apparently inherent in most insulators, unless we allow that the experimenters whose results are available have made errors of remarkable similarity.

T. Gray made an interesting series of measurements on dielectric strengths, and his results, given below, may be taken as roughly comparable, though they are open to the objections that he used large spherical surfaces, took his voltages on the primary of a step-up transformer, and assumed that a thick dielectric was produced by superposing a number of sheets:

	Maximum Strength in Kilovolts per Centimetre
Glass	285
Hard rubber	538
Soft rubber	476
Soft rubber (second quality)	492
Mica	2,000
Micanite	4,000
Papers paraffined:	
Manilla wrapping	430
American linen	540
Blotting felt	150
Fuller braid	295
Empire cloth	310
Empire paper	450
Lubricating oil	48
Linseed oil	83
Cotton-seed oil	67
Air 0.02 cm. between plates	57
Air 1.6 cm. between plates	27

The way to test a dielectric is on a length of cable. The area of surface of insulator under strain in a length of cable is enormously greater than in the case of a slab; the contract between metal and dielectric is more thorough, the curve of stress is totally different, the cable material will necessarily have to be bent about and handled, and, most important, the average value of the insulator, bubbles and all, is tried, instead of single selected square decimetre.

Bubbles are a great enemy of permanency, and tend to loss of energy, though the reason for objecting to them is not usually appreciated. If two conductors, A, C, are opposed at such a distance that the air is just able to withstand, say, 10,000 volts between them, and a strip of glass or ebonite is then introduced into the gap, the insulation breaks down, although glass and ebonite are more volt-resisting than air. The explanation is that glass and ebonite have also higher specific inductive capacity than air, consequently the potential gradient in the interposed material is less than in the narrowed air gap; the air in the gap, with its potential gradient steepened, is no longer able to withstand the pressure. It is clear that, by altering the potential gradient, bubbles may prove a source of weakness in cables; uniformity of texture should therefore be aimed at in all classes of insulating materials. In present methods of the manufacture of paper cables security is obtained by choosing an impregnating oil of approximately the same specific inductive capacity as the paper fibre, and by avoiding crumpled paper. In the case of rubber cables there should not be too great a difference between the specific inductive capacities of the materials of successive coats.

The fall of volts across an element of thickness of dielectric is greatest near the conductor and at least near the outer surface; similarly, the disruptive stress is a maximum for unit element of thickness near the conductor and diminishes from the conductor outwards. The cheapest form of cable to withstand electric stresses should therefore be one in which the dielectric strength of the dielectric in each layer is proportional to the potential gradient in that layer, at the same time having regard to the effect of difference of specific inductive capacity in all the layers. If the inner layers of dielectric are made of materials whose specific conductivities are greater than the average, the potential difference between the boundary surfaces of each of these layers can be proportionately reduced. Theoretically it is possible so to adjust the specific conductivity of all layers that the fall of potential through equal elements of thickness is the same throughout the whole dielectric; or, again, substances of dissimilar specific inductive capacities might be utilized for grading the layers of dielectric to obtain uniform stress. The grading should be calculated for the probable maximum voltage.

A brief search among the available insulators shows that it is easier, without detriment to disruptive strength, to adjust conductivities than capacities by an admixture of small quantities of a less insulating substance; but even for direct currents there is a theoretical advantage to be gained by choosing the substance with a higher specific capacity than the matrix or dielectric proper. Substances of any specific capacity immerged in a dielectric of a lower capacity tend to move slowly towards the place of steepest potential gradient. If there should remain after a careful "grading" a slightly steeper potential slope near the inner conductor, for example, of a concentric cable, a tendency is thereby established which will oppose diffusion, and will help to maintain or improve the prearranged disposition if the order of both conductivities and capacities is properly chosen. As now made, cables are often inversely "graded." A large class of fibre cables are given their final impregnation by immersing them in their entirety in a tank full of a mixture of an oil and some solid hydro-carbon, which, as in the case of resin, frequently has a higher specific capacity than the oil and paper, as well as a greater disruptive strength.

During the process of this impregnation, the fibres of the outer layers have the effect of filtering the solute from the solvent, and although the oil reaches and fills up all the pores of the innermost layers of paper, the solid is filtered away and only reaches the outer portion of the dielectric, which consequently has the greater dielectric strength and capacity where they are not wanted.

That the dielectric strength should be greater in this particular position is of little consequence, but that the capacity should be greater is a danger, because it tends to make the potential gradient steeper even than it would be in a homogeneous dielectric close to the conductor. On the other hand, it would be worth trying to utilize this fact to graduate the conductivity or capacity by choosing the oil and solid dielectric to have a suitable viscosity at the temperature of the impregnating tank.

A similar faulty arrangement is met with in ordinary vulcanized rubber cables. The pure rubber which is placed next the conductor has a specific capacity of about 2.3. The high-class compound which comes next to this may have a capac-

ity of 2.6, and be 50 per cent stronger; the outer layers, which are almost invariably made of lower grade material, have often a specific capacity of three and more, a very poor insulation resistance, and strangely enough, in some samples, up to three times the dielectric strength.

The layers of insulation on such cables are arranged in the opposite order of capacity to the most efficient, and are only enabled to stand because the vulcanized compound rubber has a sufficiently uniform texture and high dielectric strength. There is no question that, bulk for bulk, the best vulcanized rubber is stronger than the best impregnated paper, and its day will come when really high pressures are used; just now it needs all its dielectric strength to compete in cost. On armored cables their lesser diameter results in such a saving of steel tape as to allow rubber core to win in price competition.

At present rubber-covered high-tension cables have as much as double the capacity of fibre cables. This is due (1) to the specific capacities being as 3 to 2, and (2) to the superior dielectric strength of rubber, which allows the conductors to be placed nearer together. In non-concentric cables this capacity can be diminished by adding, if required, a bed or worming of jute, etc., and the reduction can be more cheaply done with rubber than if there is to be a coat of lead over each wire, which is the safest way with three-phase hygroscopic cables other than feeders.

The capacity of a perfectly graded cable is found by Mr. C. S. Whitehead to be, in all single and concentric types, inversely as the radial depth of dielectric, and the curve of potential is a straight line. The last part of Mr. O'Gorman's paper deals with the problem of determining the best thickness of dielectric as regards efficiency and price; his calculations are based on a formula proposed by Mr. Swinburne. Unfortunately the calculations depend to such a degree upon the constancy of dielectric strength that the results can only be regarded as tentative.

In the discussion which followed the reading of the paper, Mr. Swinburne, it appears to us, summed up the question of cable design along these lines very accurately when he said that the best cable would be a matter of compromise and experiment, and was not a thing which could be calculated carefully. At the same time we warmly congratulate Mr. O'Gorman upon his attempt to bring the art of cable-making into the region of precise arithmetic.

The significance of the potential gradient in cable design was pointed out by Mr. Swinburne in 1892 (*Jour. Inst. Elec. Eng.*, Vol. xxi, p. 226). He then reminded us that difference of potentials is only one of the factors that determine disruptive discharge, and that the question to be considered is not the average fall of potential taken across the whole radial thickness, but the maximum rate of fall, which is at the surface of the wire. Mr. O'Gorman tries to avail himself of this, and to design an effective cable on economical principles by grading the successive layers of dielectric. It is a pity that practical considerations stand in the way of carrying out such a pretty scheme. The cable maker weighed down by the tremendous responsibility of his own reputation is obliged to choose a design that will stand fair wear and tear, and that will not be valueless when the inevitable weak place appears. For this reason he prefers to use a dielectric which is fairly good all through to one in which the strength is localized in a few thin layers. He has, in fact, to anticipate the presence of the bubble or a bit of copper in those thin layers. He is also aware that in the multiplicity of layers there is weakness and expense, for each layer encloses its film of moisture and dirt, and each layer means an extra man or two at the machine. The material has to be sufficiently thick to withstand the stress of the covering operation. The purer layers, of india-rubber say, could be comparatively thin, but the pigmented layers must necessarily be thicker or they will break off in the machine. One can not do much in a millimetre. It is as well, therefore, to keep to the rule of three. In the cases of cores of such material as gutta-percha, where the successive layers depend for their adherence upon a mixture such as Chatterton's compound, it would be very risky to exceed that rule, for the compound might act injuriously upon the layers, whether the dielectric be paper, india-rubber or what not. It can be accepted as a general principle that the greater the multiplicity of layers, the greater the number of chance paths for present and future dirt and moisture. There is virtue in solidity. If, however, the layers are, as it were, welded together by heat, or caused to interpenetrate by the use of oils, this difficulty might be lessened. But then we are met by the complex question of the effect of this surface mixing upon the dielectric constants of the various layers, and it is extremely doubtful whether the "grading" would come out right after the process. It might even be reversed.

The cable maker who tries to make a "graded" cable is also confronted with the difficulty of obtaining by a proper choice of materials a series of mixtures of the required simultaneous specific inductive capacities, specific resistances, and dielectric strengths. These qualities can not easily be attained by calculation, and when they have been attained, who knows how long, and under what circumstances, they will keep their values? The problem has been attacked in part by Dr. C. H. Lees in a paper read before the Physical Society, November 24, 1899. He alludes to the case considered by Maxwell, who worked out the conductivity of a compound medium formed by embedding spheres of a given material in another medium of different conductivity. Maxwell also worked out the conductivities for two other cases of compound media. (1) When the two media are separated by planes either parallel or perpendicular to the plane equipotential surfaces in the media; and (2) where the parts of the two media consist of right prisms of rectangular cross-section, one dimension of the cross-section being infinitely great compared to the other, and the length of each prism being again infinitely great compared to this greatest cross-sectional dimension, placed with their edges either parallel or perpendicular to the equipotential surfaces. It is pointed out by Dr. Lees that these three cases have restricted application only; he, therefore, takes the more general case of a medium form of an equal number of infinitely long prisms of square cross-section, of two media having conductivities K_1 and K_2 arranged like the squares on a checker-board, and bounded by two parallel equipotential planes drawn through the diagonals of the cross-sections of the prisms. Dr. Lees recognizes the difficulty of selecting a distribution of the prisms which shall represent the general case of conduction through such a mixture, but he arrives at three equations corresponding to three definite cases. The conductivities determined for successive equal increments of one constituent of the mixture, correspond for the first equation to the successive terms of an arithmetic series, for the second to the terms of a harmonic, and for the third to those of a geometric series. The meaning of this is that a manufacturer is unable to calculate the electrical constants of a dielectric mixture from the known constants and proportions of its constituents; the resulting compound may have a value corresponding to the arithmetic, the harmonic, or the geometric mean, or to neither of these. Moreover, the results of his most academical pretensions to refinement in mixing may be marred by some difference in preparation and cure. And beyond all that he must take account of the change of the dielectric "constants" with time, he must keep within the limits of price, and he must sell an article at least as durable as his reputation.

The Holland Electric Submarine Boat.

Mr. John P. Holland, well known as the inventor of the submarine boat, has recently obtained two patents on improvements therein. Both of these patents have been assigned to the Electric Boat Company, a corporation organized under the laws of New Jersey. The first patent covers the general structure of a submarine vessel, especially designed for use in war, and adapted for operation both on and under the surface of the water. In the accompanying drawings, which illustrate an embodiment of the invention, Fig. 1 is a longitudinal vertical axial section of the submarine vessel. Fig. 2 is a transverse section of the same on a scale double that with air cocks, *n*. The purpose of this construction has been explained. The air tanks, *m*, occupy the spaces left in tapering the branches, *i'*, of the ballast tank. This tank is normally closed to the water of flotation and below the water line of the vessel. The other patent refers to mechanical means for causing the boat to find a predetermined level below the surface.

Fig. 1.

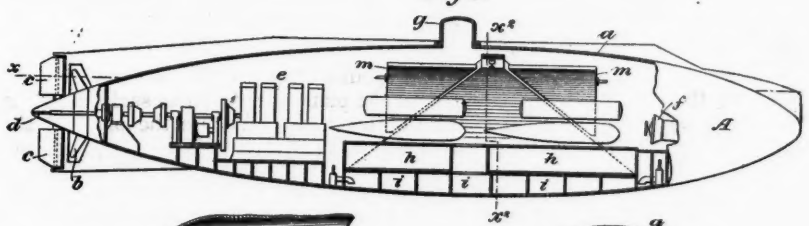


Fig. 3.

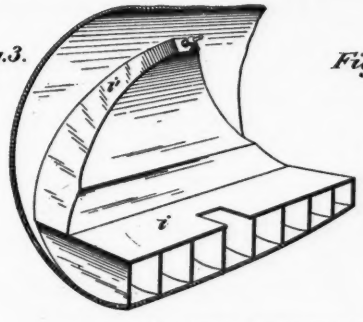
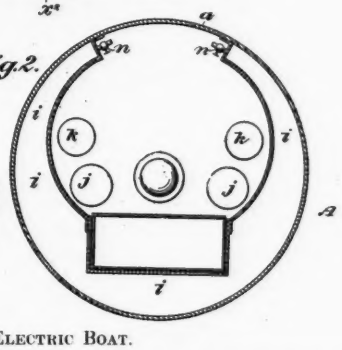


Fig. 2.



HOLLAND'S SUBMARINE ELECTRIC BOAT.

of Fig. 1, the plane of the section being indicated by line x^2 in Fig. 1. Fig. 3 is a perspective sectional view of the water-ballast receptacle detached. A represents the hull or body of the boat, and *x* the water level when the boat is running on the surface. The part, *a*, of the hull or body above the line, *x*, is called the "emersed" portion or body. *b* is the propeller; *c*, the rudders for horizontal steering; *d*, the rudders for diving; *e*, the engines; *f*, the expulsion tubes; *g*, the conning-tower or turret; *h*, the storage batteries or accumulators; *i*, the water-ballast tank or receptacle; *j*, the spare torpedoes; *k*, the tanks above them to contain water to compensate for expended torpedoes, and *m*, the tanks for the storage of compressed air. It will be noted that the water-ballast receptacle, *i*, is horseshoe-shaped in cross-section, that its upright branches, *i'*, follow the curve of the sides of the cylindrical body of the boat, and that these branches, *i'*, are tapered upward at their fore and aft ends, being provided at their highest points

Self-Propelled Vehicles in Europe.

United States Consul Thornwell Haynes writes from Rouen as follows: Not long since, the automobile owners in France received a circular from the artillery station at Vincennes regarding the conditions upon which automobiles could be bought, should mobilization become necessary. The Minister of War in Germany is having vehicles constructed with tables upon which officers can consult their maps while on the march, and also as ambulances, and to carry guns, ammunition, etc. In the recent German military movements, automobiles, motocycles, and bicycles entirely replaced horses in the service of the general staff. To obviate expense and delay in special construction of railroads for campaign purposes, the ministers of war of Austria-Hungary and of Italy are having automobiles built solely for rapid mobilization. The latter has offered prizes for types fulfilling certain conditions. The Secretary of State for War in England has offered prizes amounting to more than $4,000 for the best self-propelled lorry, or wagon, for military purposes.

The great objection to electric motors —that they will not run far enough without recharging—is said to be overcome. It is recorded that recently in England a circuit of 94 miles was run without recharging. It was done with a battery of 42 four-plate cells, with a capacity of 180 ampere-hours. The carriage was a four-wheeled dogcart, with two motors of two and one-half horse-power each. The secret of the battery which enabled it to make such a record was that in going down grade the motors were reversed, thus making dynamos for charging the accumulators. In this way the current was not only saved, but a new current actually generated, rendering the battery stronger at the bottom of the grade than it was at the top. Might not the wasted energy of the automobile as it flies down American hills be utilized?

The Fourth International Automobile, Cycle and Sports Exposition is to be held in the Grand Palais, Paris, December 10 to 25, 1901. The condition of entry is generally the same as was in force during the last exposition, with the exception that the price of space, which remains the same in the nave of the building, will be diminished in the less favored localities. There will be the following classification:

Automobiles, motocycles and all vehicles of mechanical traction, cycles of all kinds, material for the construction of automobiles and cycles, tires, detached pieces, accessories, motors, navigation, aërostatics, miscellaneous sports and touring, body work for automobiles, automobile and cycle costumes, inventions, automobile and cycle literature, and photography.

The president of the committee of organization is M. Gustave Rives. Letters will reach him addressed in care of the Automobile Club of France, Hotel Plessis-Belliere, 6 place de la Concorde, Paris.

The Holland Industrial Cycle and Automobile Association has organized an international exposition for the month of February, 1902. It will be held at Amsterdam.

Fund for Scientific Research in France.

Legal authority has been given for the creation of a fund for scientific research in France. It is divided into two sections, and its object is the promotion of purely scientific work relative (1) to the discovery of new methods of treatment of the diseases which attack man, domestic animals and cultivated plants; and (2) to the discovery, apart from the medical sciences, of the laws which govern natural phenomena (mechanics, astronomy, natural history, physics and chemistry). The fund is subject to the authority of the ministry of public instruction, and is managed by a council assisted by a technical commission concerned with the grants.

Views, News and Interviews

Mrs. Charles Conover, of Nanuet, N. Y., while sitting in a chair on a piazza during a severe thunder-storm was shocked into unconsciousness for seven hours. After making an examination it is reported that the village doctor found that the shock had turned Mrs. Conover's heart upside down. Mrs. Conover is apparently as well as ever.

A very severe thunder-storm recently passed over Hazleton, Pa. It is stated that a bolt struck a Hungarian boarding house, and passing between two boarders who were asleep picked them up and threw them in opposite corners of the room without injury. A baby lay asleep in a cradle, and the cradle was crushed, but the baby escaped uninjured.

Much progress is being made by electrical industries in Argentina, especially in Buenos Aires. There are several factories which turn out switchboards, and even small dynamos. The imports of electrical supplies imported during 1900 were 648 dynamos, value in gold, $80,025; electrical material to the value of $341,-034; insulated wire and cable, $511,709; incandescent lamps, $101,112; telephone material, $20,143; telegraph material, $36,993. Germany, Belgium, England, France and the United States furnish the most of this; Holland and Italy a small portion.

Very few people have heard of automobile banks. Such, however, is the case, and the new institution is the property of the town of Mézières, in the Ardennes, France. In order to reach a savings bank the peasantry there have been compelled to leave their work and come to town, which meant to many a journey of several miles. Now, instead of having to go to the bank to deposit their savings, the residents on the outskirts of Mézières will have the bank brought to them. The new vehicle is unique in construction. It is propelled by electricity and has four seats, one in front for the driver and three in the rear for the staff of the institution. These three seats surround a revolving table located in the centre of the carriage, on which the business of the bank may be transacted. Writing desks capable of being folded up when not in use are arranged over each of the seats in such a way that when open they extend out from the sides of the carriage in a manner suitable for the use of persons standing outside who desire to open an account with the bank. On the table are to be found shelves for books, adequate stationery for the use of the clerks, and a small metallic strong box. On certain prearranged days the car makes a tour of the country districts, stopping here and there as long as it may be necessary to dispose of the business in hand.

Production of Iron and Steel Rails.

The collection of statistics of the production of all kinds of rails in the United States in 1900 has been completed by the American Iron and Steel Association: In March last the production of Bessemer steel rails by the producers of Bessemer steel ingots in 1900 was given as amounting to 2,361,921 gross tons. To this total must now be added 21,733 tons of Bessemer rails made in the same year from purchased blooms and rerolled and renewed Bessemer rails, making a grand total for the year of 2,383,654 tons of Bessemer steel rails. In the same year we also made the largest quantity of open-hearth rails in recent years, 1,333 tons, and the smallest quantity of iron rails ever recorded, 695 tons, which, added to the Bessemer steel rails above given, make the total production of rails in 1900 amount to 2,385,682 tons, the largest production ever attained in one year.

The following table gives the total production of rails in the United States in 1900 according to the weight of the rails per yard. Included in the total production are 101,312 tons which have been definitely reported as street rails. These figures are in long tons:

Kinds.	Under 45 lbs.	45 lbs and less than 85.	85 lbs. and over.	Total.
Bessemer	155,970	1,625,646	602,058	2,383,654
Open hearth	886	447	.....	1,333
Iron	695	.....	.....	695
Total	157,531	1,626,093	602,058	2,385,682

The total production of all kinds of rails in 1899 was 2,272,700 tons, of which 133,836 tons weighed less than 45 pounds to the yard, 1,599,340 tons weighed 45 pounds and less than 85 pounds, and 579,524 tons weighed 85 pounds and over. The street rails made in 1899 and reported amounted to 154,246 tons.

Condolence from Our British Colleagues.

The following cablegram has been received by Secretary R. W. Pope, of the American Institute of Electrical Engineers, from the president of the Institution of Electrical Engineers of Great Britain:

"London, September 19, 1901—President American Institute of Electrical Engineers, Members Institution Electrical Engineers, London, tender sympathy yourselves and American nation in sad death President McKinley.

"(Signed) LANGDON, President."

Death of the President of the Chesapeake & Potomac Telephone Company.

Judge Jeremiah M. Wilson, of Washington, D. C., president of the Chesapeake & Potomac Telephone Company, and chief counsel for Rear-Admiral Schley, died suddenly at the Shoreham Hotel, Tuesday morning of this week. Death was supposed to be due to heart disease. Judge Wilson was a distinguished lawyer of Washington, and had been at the head of these telephone interests for some time past.

Proposed New German Tariff.

The following are the new tariff rates on electrical machinery in the proposed new German tariff:

	Marks.	
Electrical machinery, viz., dynamos, electric motors, converters, transformers, etc., for machines under 500 kilogrammes in weight, per 100 kilogrammes....	9	$2.14
Same from 500 to 3,000 kilogrammes	7	1.66
Same (more than 3,000 kilogrammes in weight)....	6	1.42
Machine tools for working metals, wood, or stone, steam and hydraulic presses, welding machines, mechanical hammers, as follows:		
250 kilogrammes in weight.	20	4.76
From 250 to 1,000 kilogrammes	12	2.85
From 1,000 to 3,000 kilogrammes	8	1.90
From 3,000 to 10,000 kilogrammes	6	1.42
Over 10,000 kilogrammes...	4	.97

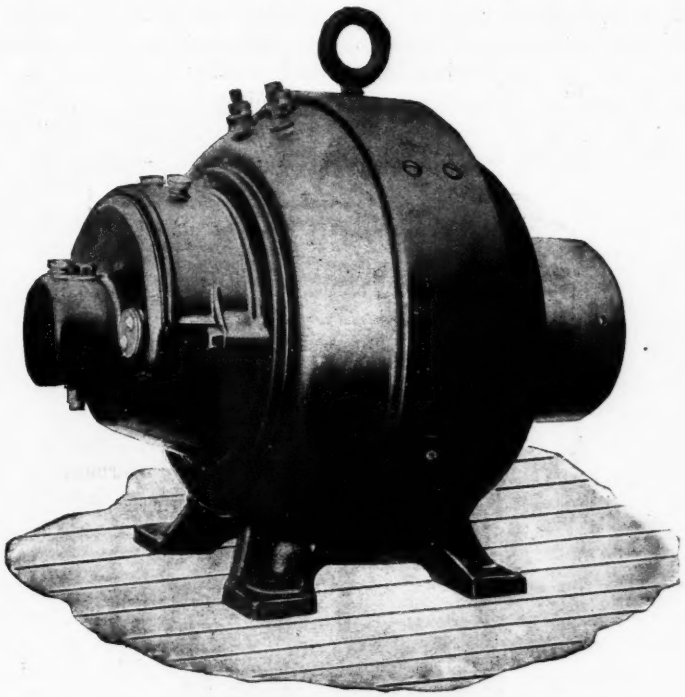
Steam engines, turbines, gas and caloric engines, blowing machinery, pumps, portable cranes, pile drivers and power hammers, ice machinery, etc., range from a rate of $23.80 per 100 kilogrammes for machines weighing less than 40 kilogrammes each down to $4.28 for machines between one and two tons in weight, and so on down to 83 cents per 100 kilogrammes for machinery weighing more than 100 tons each.

	Marks.	
Telegraphic instruments, telephones, electrical lighting and power-transmission apparatus, electrical measuring instruments, etc.	60	$14.28
Motor, railway, and street cars	10	2.38

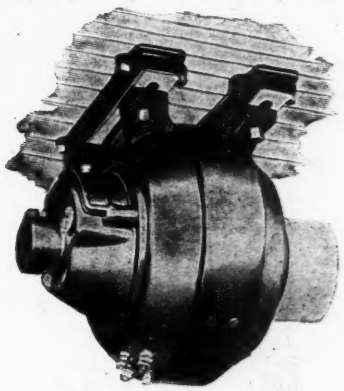
Multipolar Motors for Power Work.

In the accompanying illustrations are shown in detail a type of enclosed dustproof multipolar motors for general power purposes, manufactured by the Paragon Fan and Motor Company, New York. These machines range between one and 10 horse-power, with speeds from 500 to 900 revolutions per minute. More particular attention has been paid to the question of rating and capacity, and the overload capacity of these machines is calculated for a maximum of 100 per cent, this being the practical limit of commutation.

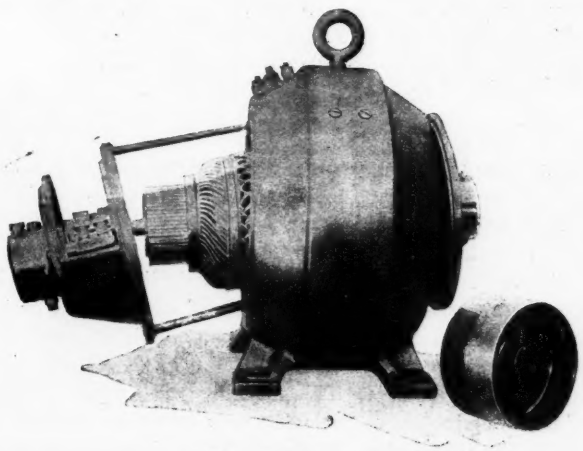
The armature is built up of japanned sheet steel disks, each of which is keyed to the shaft. The coils are form-wound, and are held in place by wooden strips engaging with dove-tails in the sides of the teeth. All of the coils are mica-insulated. Special cast iron of high permeability is used for the frame, and the pole-pieces are fully laminated. The field laminations are of the same thickness as those in the armature, and are held together by hollow rivets; they are bolted in place on the field ring of the machine. The commutators are of the most substantial construction and carbon brushes are used throughout, in holders of the "parallel-motion" type. The machine is made for side walls or ceiling support, as well as of the usual type, and the greatest care has been exhibited in its mechanical construction.



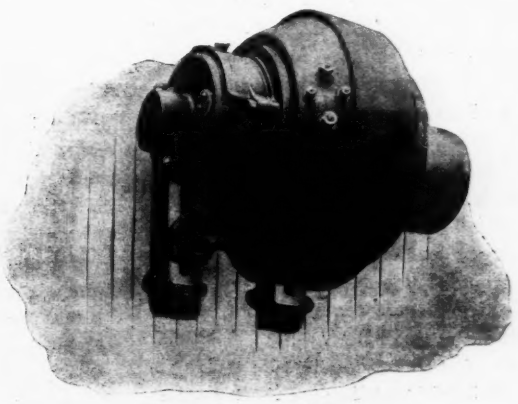
ENCLOSED DUSTPROOF MULTIPOLAR MOTOR.



CEILING TYPE OF MOTOR.



MOTOR DISASSEMBLED.



WALL TYPE OF MOTOR.

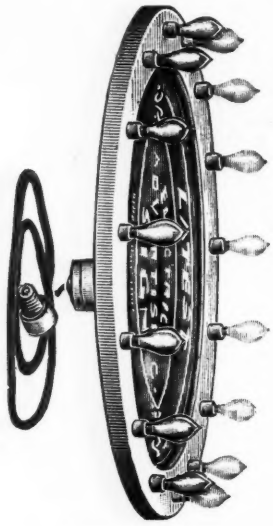
Proposed Cable to Hong Kong.

United States Consul-General W. A. Rublee, at Hong Kong, reports that in connection with the proposed construction of a cable from the United States to Manila and its eventual connection with Hong Kong, the business community of Hong Kong takes a keen interest in obtaining additional cable facilities. The rates charged by the present cable companies have been a source of long-continued dissatisfaction, and an American cable company that would be the means of reducing rates would be extremely popular in the Orient, and should receive a large share of local patronage.

The present cable traffic between the United States and Hong Kong is from $1.65 to $1.75 (United States currency) per word. It is reported that an American cable company would establish a rate not exceeding $1 a word. Such a reduction would be a great boon to the business men in the Orient. The chairman of the Hong Kong Chamber of Commerce last month, at his suggestion, brought the matter before the committee of the chamber, and this representative institution indorsed the project, expressing the opinion that the increased facilities afforded by reduced tariff rates would lead to a very considerable expansion of trade between the far east and western countries.

A New Electric Sign.

It appears that the demand for electric signs is increasing very rapidly and a corresponding effort to fill it has been caused. For the most part such signs have been costly and elaborate, while large numbers of people desire those which involve only a moderate outlay. A recent effort to produce a cheap electric advertising sign has been made by the American Miniature and Decorative Lamp Company, of New York. This is shown in the illustration which is produced from an actual sign. The lamps are arranged in a circle of wood, coated with fine white enamel, in which a varying number of special eight-candle-power lamps are set. At present the sizes include 15, 12 or 8 lamps in multiple, and



Electric Sign.

16 or 8 in series. Each ring is furnished with cord and plug and can be instantly connected up to any convenient socket. Suppose the cost of running two ordinary 16-candle-power lamps for five hours nightly be taken at $2 per month, then such a sign, which is far more effective for advertising purposes, should pay for itself in four months. The management states that other shapes are now being built which embodies the same idea of encircling or enclosing the advertisement with a rim of powerful light. The place for the sign in the centre can, of course, be easily changed at any time. A special design of eight-candle-power lamps is used. It is said that they are much smaller than anything of the kind which has been previously used.

In 1900 the production of carborundum was 1,300 tons, as against 807 tons the year before. Carborundum is an abrasive material made in the electric furnace.

Electrically Driven Grinders.

Grinding as a method of finishing work has become too well understood among the more advanced machine manufacturers to need an introduction here. This method of finishing all work, either hard or soft, is much cheaper than the old file and emery cloth. It is also applicable to finishing all classes of work that have heretofore been finished in a lathe.

Grinding machines to be successful must not only be properly designed, but a degree of accuracy is necessary in their construction not required on any other machine tool. They must be massive in proportion and capable of quick and convenient handling. Although contact-driving of machine tools by means of motors is coming into general use, there are but few the market designed with this in view. In the majority of cases it is simply a question of fastening the motor of some standard make to the frame of a tool designed for belt driving, being at the best a makeshift. The Lea grinder, manufactured by the Anderson Tool Company, of Anderson, Ind., is an electrically driven tool in every detail, as both motor and machine are designed to work together and are built and tested in the same shop. Universal grinders, from the peculiar nature of their work, are better adapted to this mode of driving than most other machine tools, having as they do from eight to ten belts, some of which have to be removed for almost every operation. The belts not in use hang in the way and are always giving more or less trouble when running at a high speed. The work of a universal grinder requires that either the wheel or the piece being operated on should occupy almost every conceivable position. This is done much more easily and quickly where the wheel is made to move.

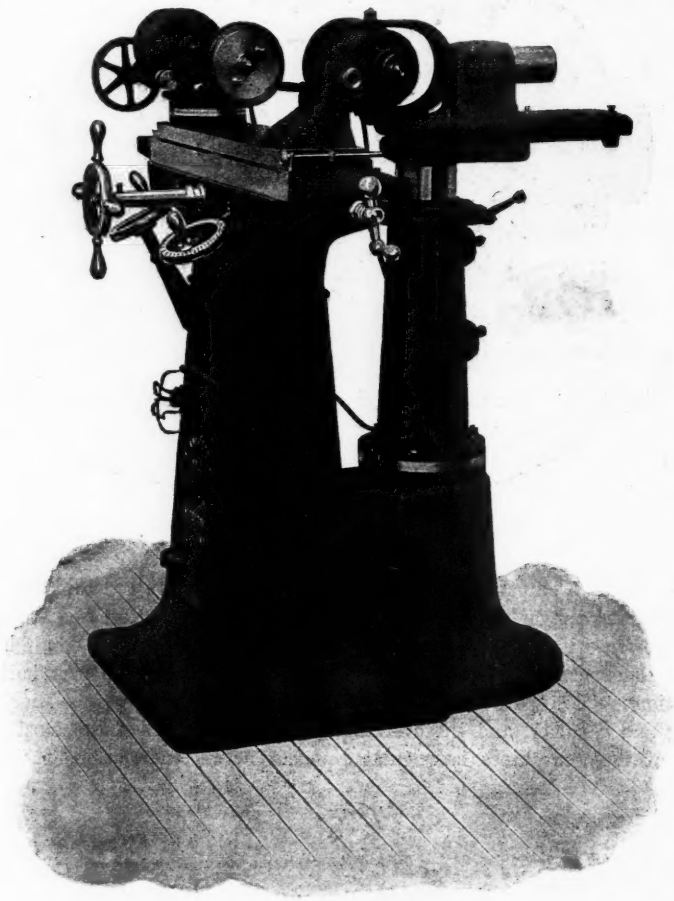


Fig. 1.—Cutter and Reamer Grinder.

In the cutter and reamer grinder shown in Fig. 1, practically all work is held between a pair of plane centres or in a vise and the wheel moved instead of the work, thereby making a large saving in time. This machine, while intended more particularly as a cutter and reamer grinder, is adapted for all classes of tool-room work and has a very great range.

The main table has a movement of 24 inches parallel with the bed and is fitted with swiveling top graduated to 11 degrees each side of the centre and actuated by a knurled screw. By the use of a turnstile wheel the table is moved by a rack

and pinion for rapid work or for cutter grinding. The handle at the end of the table gives micrometer feet for facing work held in the chuck and is graduated to thousandths. The head-stock on which is mounted an independent motor is swiveled entirely around the circle. It is graduated in degrees and works equally well in all positions. The grinding motor is mounted in a universal form which allows its operation in any position, either vertical, horizontal or at an angle.

By the use of the left-hand wheel the motor-head can be depressed or elevated, allowing a cup-wheel to be used for knife grinding, either at right angles with the top table or even with the motor shaft in a vertical position. It can be elevated nine inches for grinding-formed cutters between centres, or for larger cutters the wheel shaft may be vertical and the grinding be done from the side. The elevating wheel is graduated to thousandths. The right-hand wheel moves the grinding motor to and from the centre and is also graduated in thousandths.

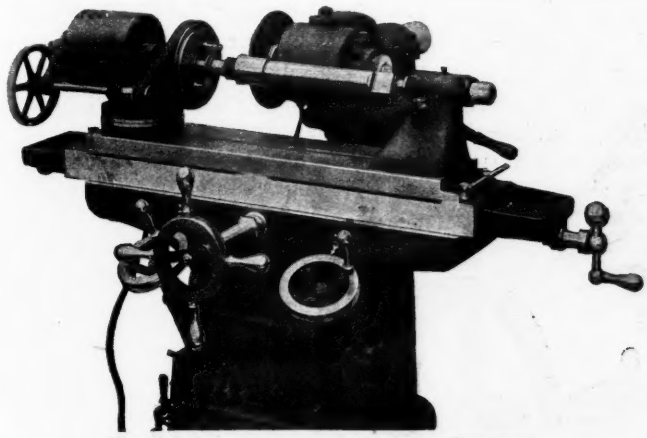


FIG. 2.—ADJUSTMENT FOR CIRCULAR GRINDING.

FIG. 4.—MACHINE ADJUSTED FOR A GRINDING ANGLE CUTTER.

The grinding motor is mounted in a double universal joint allowing the motor to face in any position throughout the entire circle, either horizontal or vertical. The motor fork is clamped in the sleeve and has an adjustment of four inches, in addition to the double slide. The motor is entirely enclosed on the wheel end and has the finest quality of ball bearings. It is only necessary to use a small amount of grease on it about once in two weeks. This feature is extremely valuable where the motor has to be run vertically, as it is almost impossible to keep oil from working into the windings. The bearings are adjustable from one end. The motor has five speeds, varying from 1,800 to 3,200 revolutions per minute. It is reversible by a switch and works equally well when running in either direction. The motors are especially designed for this work. They are wound with the best quality of silk-covered wire and provided with mica insulation. They are said to be perfectly balanced, free from sparking and with reasonable care to give much less trouble than belts. The switchboard is fitted to the side of the machine and connected to the motor by rubber-covered cables. It is fitted with a rheostat for regulating the speed of each motor, with a reversing switch for the wheel motor and with a starting switch for both. This machine as shown in Fig. 2, while it is intended more particularly for a general tool-room grinder, also makes an entirely satisfactory machine for circular grinding within its range. Pieces 18 inches long and up to 9 inches in diameter can be handled, although it is better not to grind a solid piece of this size in such a small machine. The face-plate runs loose on the end of the spindle, allowing the work to be ground by dead-beat centres or by tightening the set screw on live centres. The tail-stock is held in position by a spiral spring and is drawn back by a small lever shown at the right-hand side. For circular grinding the motor can be run in either direction, and at the same time can be swung around in the fork, bringing the wheel at either end of the work and thereby reaching positions which are not often possible with such a machine.

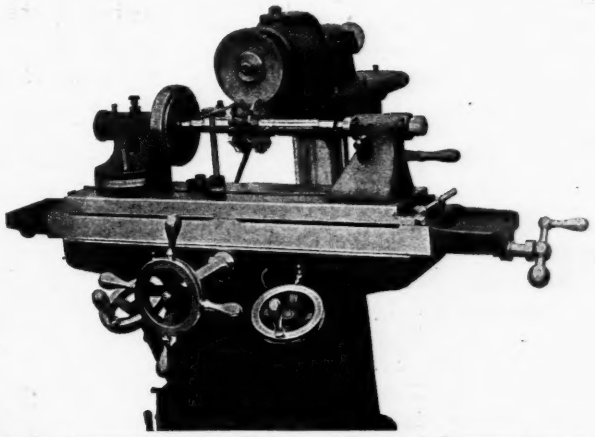


FIG. 3.—ADJUSTMENT WHEN USED AS A GRINDING FORMED CUTTER.

This machine may be used for a grinder-formed cutter. It is simply necessary to place the cutter on the arbor between the centres, elevate the wheel column by the left-hand wheel, run out across the slide to the necessary position over the centres and obtain the proper angle by tilting the motor as shown in Fig. 3. Where the cutter is too large to be handled in this way, the motor can be turned to a vertical position and the cutter ground from the side.

When used as a grinder angle cutter, it is best done with a small cup-wheel, as depicted in Fig. 4, but can be performed equally as well with a disk-wheel by changing the position of the motor. The angle is easily obtained by the swiveling head-stock, or, if preferred, by the swiveling-wheel column.

The practical sense of the German nation is evidenced by a ministerial decree forbidding motor-car racing in public thoroughfares throughout Germany. So far as Germany is concerned, then, there are to be no more of those senseless competitions, the results of which have been quite devoid of any practical value, except to show their futility. It is noticeable that strong opposition to automobile "scorching" is also appearing in the United States.

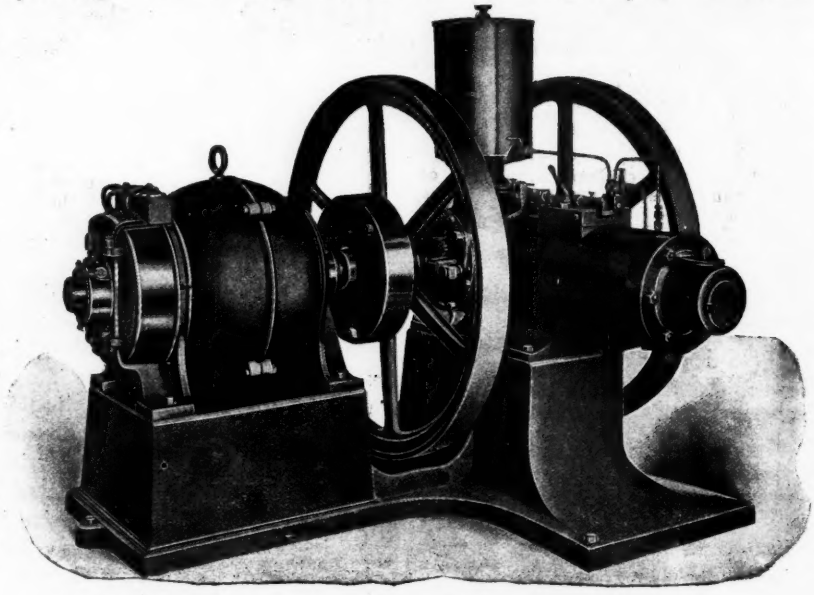
Kerosene Engine and Generator Direct-Connected.

Mr. August Mietz, of New York, is now manufacturing and putting on the market a combination of an electric generator directly coupled to a kerosene engine. It is known as the Mietz & Weiss kerosene engine and works on the two-stroke cycle. The piston receives one power impulse per revolution, the explosion of the compressed mixture of air and vaporized oil taking place at the beginning of the forward stroke and the release occurring at the end, the next supply of oil and air being injected on the return stroke. This generating unit is intended especially for electric lighting. It is considered well adapted for this service, since it always receives a fresh charge of oil at every revolution when working at full power.

The accompanying reproduction from a photograph shows a view of the direct-connected set. The cylinder, with its water-gearing packet, is cast in one piece with a chamber enclosing the space through which the crank turns and forming practically an extension of the rear ends of the cylinder. The crank-shaft bearings are carried by the side heads of the chamber. They are of phosphor-bronze, and are made with large wearing surfaces. The mechanism of the engine is rather simple. No valve nor side shafts are used, as the ports in the cylinder are so placed that they are opened and closed by the movement of the piston. The crank chamber supports a reservoir where the oil is stored, and the oil is forced into the cylinder by a small pump, which is placed on top of it. An eccentric on the crank shaft operates the pump, which is controlled by a governor of simple design. These are the only moving parts of the engine except the crank and piston.

In brief, the action of the engine is as follows: When the combustion of the intimate mixture of oil and air has taken place the piston moves forward and expansion of the products of the combustion occurs. The air in the rear end of the cylinder and in the crank chamber undergoes a compression during this stroke. After the release has taken place at the end of this stroke the air from the crank chamber enters the cylinder clearing it of the waste gases, the cylinder being still open to the exhaust. The piston then moves to the head end of the cylinder on the return stroke and at a certain point of the return stroke the pump comes into play and forces oil into the cylinder. The oil is vaporized when the oil and air are compressed, and at the beginning of the next forward stroke the heat of compression and of the cylinder walls, etc., is sufficient to cause the explosion. An ordinary flame igniter, placed at the end of the cylinder, and which is used only a few minutes, starts the engine.

The oil pump is a plunger pump with an extended rod which is arranged to be stopped whenever a decrease of speed indicates a need for more oil. The projecting rod is actuated by the governor, which consists of a moving link pivoted to the upper end of a lever that has a rocking motion imparted by the eccentric. The free end of the link slides upon an inclined plate on the back of the engine and has a reciprocating movement along it. The free end passing up the inclination will strike the piston and force the requisite amount of oil into the cylinder, when the engine is running at normal speed. If, however, the speed exceeds the normal inertia of the free end up the inclined portion of the plate and becomes sufficient to cause it to continue in its direction, it is elevated and misses the plunger. During that revolution, of course, the engine would receive no impulse. The above cut shows a direct-coupled, four-horse-power engine, which is made to run at 400 revolutions per minute, and drive a generator giving forty 16-candle-power lamps. It is stated that its consumption of kerosene per horse-power per hour is about 1.32 pounds of oil of 150 degrees test.



KEROSENE ENGINE AND GENERATOR DIRECTLY CONNECTED.

A Correction.

The subject of the paper read at the recent meeting of the Municipal Electricians, at Niagara Falls, N. Y., by Mr. P. H. Alexander was "Magnetic Car Brakes" instead of "Electric Carbons," as published in the ELECTRICAL REVIEW.

The Charles E. Dustin Company.

The Charles E. Dustin Company has been formed to engage in the purchase and sale of all kinds of electrical machinery, engines and boilers, and to construct electric and steam plants and do general engineering. Mr. Charles E. Dustin, well known in electrical circles, is the president and general manager and will have associated with him Mr. W. S. Barstow, formerly general manager of the Edison Electric Illuminating Company of Brooklyn, who as consulting engineer will devote a large part of his time to the interests of the new company. Mr. Dustin is one of the pioneer electrical manufacturers of the United States, having organized the Schuyler Electric Company, of Hartford, in 1882, and remained with it as general manager until it was absorbed by the General Electric Company. Some 75 electric lighting plants of this system were installed under his management. Mr. Dustin afterward was connected with the Excelsior Electric Company, and more recently accepted the presidency of the well-known house of Rossiter, MacGovern & Company, of New York, with which he has been actively identified for over a year past, and from which he retires to organize the Charles E. Dustin Company, with headquarters in New York city. Mr. Dustin is also president of the Standard Manganese Company, of Santiago, Cuba, to which he will devote a portion of his time. The new company starts its business career with the brightest prospects, which the ability of its constituent members will doubtless soon turn into definite achievements.

Current Electrical News

COMMERCIAL NEWS

DOMESTIC AND EXPORT

The Cunard liners, Umbria, Campania and Etruria, are to be fitted with Marconi wireless telegraph apparatus.

The Minneapolis General Electric Company, of Minneapolis, Minn., now has control of the International Electric Company. The property has just been purchased.

A new substation is being erected in Tacoma, Wash., by the Snoqualmie Falls Power Company. It will be the most attractive building yet erected by the company.

Mr. R. W. Ferris is preparing plans for a power plant to be installed at American Falls, Ida., by Mr. J. H. Brady, owner of the electric plant at Pocatello. The plant will cost about $150,000 and will develop 300 horse-power.

The Twin City Telephone Company, of St. Paul, Minn., has filed in the office of the city clerk a $1,000,000 trust mortgage which covers its plant in St. Paul and Minneapolis, and provides for the large bond issue made by the company last May.

The municipal commissioners of Singapore have voted $75,000 to be expended upon electricity supply works, and according to advices from that part of the world are taking counsel with Burstall & Monkhouse, engineers of Singapore, as to the most suitable system.

Articles of incorporation have been filed in the county clerk's office, in Trenton, N. J., by the St. Louis & Illinois Suburban Railway Company, with an authorized capital of $3,000,000. The new company will absorb the St. Louis Traction Company and several small suburban roads.

The Hamilton, Hughes & Monroe Telephone Company, of Hamilton, N. Y., has begun erecting poles in that city. It is now stated that both the Hamilton, Hughes & Monroe Company and the Western Butler County Telephone Company have become a part of the United States Telephone Company, the great independent system which the Everett-Moore Syndicate, of Cleveland, is building.

A movement is under way for a general conference of the operating officers of the railroads between New York and Chicago, to consider suggestions for operating suburban passenger trains by electricity. It is said that propositions have been submitted by electricians to substitute electrical power for steam, with guarantees that heavy trains can be moved with regularity and safety at the rate of 70 miles per hour.

A plan of reorganization for the Washington Traction and Electric Company has been prepared. The new company shall authorize an issue of $17,500,000, 50-year four per cent gold bonds, and $6,500,000 common stock. Assenting security holders will receive for each $1,000 bond $550 in new 4's $550 in preferred stock and $200 in new common stock. For each $100 of stock on payment of $9 cash $9 of new preferred stock and $30 of new common stock will be received.

The plans for the proposed plant on the Payette River 20 miles west of Boise, Ida., are nearly completed. The Boise-Payette River Electric Power Company, of which Mr. Judson Spofford is the general manager, will construct this plant. The estimated cost is $200,000 and the bids will probably be wanted in November. The power will be obtained from water through a canal three and one-half miles long with a fall of 39 feet. The water-wheels and generators will be direct-connected.

It is reported that the London County Council has decided to send its tramway manager and chief electrical engineer to the United States to study the latest American improvements and the best system of providing electric traction. The council controls 80 out of the 115 miles of tramway in the British metropolis, and the passing of its tramway bill, which was recently approved by the House of Lords, will enable the council to considerably extend its ownership of private systems in the near future.

It is reported that Senator Clark, of Montana, is planning to run an electric road from Salt Lake City, Utah, to San Francisco, Cal., and as the line has been mapped out it will run through Sacramento. The road is to be devoted exclusively to passenger traffic. Portions of some of the old railroad lines in the East have been fitted out with electricity, and as they have proved successful that fact gave Senator Clark the idea of building an electric road across the country. His idea is to have trains of three cars, carrying only passengers and baggage.

The illuminated street signs on the electric light poles in front of the Tribune Building, in New York, have attracted much favorable comment, and the Edison company has placed a few similar signs on poles in Fifth avenue and other parts of the city at its own expense as an experiment. Many citizens who have observed the signs have expressed the hope that the city authorities would authorize placing signs on all the electric light poles at the street corners. It is declared that such signs would go far to aid strangers in finding their way about the city, although there are not enough electric light poles on the street corners to carry all the electric light signs that are needed.

President Jacob L. Greatsinger, of the Brooklyn Rapid Transit Railway Company, has suggested to Deputy Police Commissioner York that the police aid in preventing trolley accidents in the future. President Greatsinger believes that the danger may, to some extent, be obviated if very young children are not permitted to play in the streets where the cars run. It was pointed out to Mr. York that of the deaths reported from trolley accidents during the last eight months, 17 of those killed were little children. The plan of segregating the children in the quiet streets is not regarded as possible by the deputy commissioner. However, he promised to do all in his power to assist the railroad officials.

Despatches from Honolulu, H. I., state that the British cable survey ship Brittania, has arrived there from Suvaa after surveying the route of the British Pacific cable from Fanning Island. The greatest depth from Suvaa and Fanning Island was 3,150 fathoms. From Norfolk Island to Fiji and thence to Fanning Island and on to Vancouver, the bottom of the ocean has an average depth of 2,800 fathoms with only one range of submarine mountains that come within 700 fathoms of the surface. These are near Norfolk Island and have been named Brittania Range after the cable-ship. The cable laying will begin at the Australian end by the specially constructed steamer Anglia. The cable will not come nearer to Honolulu than 200 miles, while the nearest station is Fanning Island, 700 miles distant.

ELECTRIC RAILWAYS

Work has been begun on the extension of the electric line from Indianapolis, Ind., to Centreville.

The Milwaukee Electric Railway Company, of Milwaukee, Wis., is to have a new power-house in that city.

A party of surveyors has commenced surveying and locating tne track for the trolley road from Sidney to Utica, N. Y.

Work is being pushed upon the extension of the street railway line in Duluth, Minn., to the eastern end of the city.

It is expected that the laying of ties and rails on the Danbury, Ct., and Harlem road will be commenced within a short time.

The Hazleton Traction Company's engineers are placing the grading stakes for the new trolley line going through Albert, Pa.

The work on the Aiken-Augusta trolley line in Augusta, Ga., is being pushed over the hills toward the South Carolina terminus.

The York Street Railway Company, of York, Pa., has extended the car tracks on North street to the intersection of Duke street.

Mr. C. R. Twiss, engineer of the Kansas City & Leavenworth Electric Line, has just completed another survey from Independence to Cherryvale, Kan.

Mr. E. C. Hanner, of Syracuse, has arrived in Little Falls, N. Y., where he will have charge of the work of laying the track for the new electric railroad.

The State Railway Association of New York has granted to the Syracuse, Skaneateles & Moravia Railroad Company the right to build an electric road from Moravia to Syracuse.

The Central Rapid Transit Company, of Scranton, Pa., has again made application for a franchise for a street railway in that city. This time the request is accompanied with an offer of $12,000.

The Cincinnati & Indianapolis Traction Company, of Indianapolis, Ind., which was organized for the purpose of building an electric line from Indianapolis to Cincinnati has been incorporated.

The contract for the foundations of the new power-house of the Rhode Island Suburban Railway Company has been awarded to Mr. F. E. Shaw. The cost of the substructure is about $80,000.

A meeting of the people of Huron, N. Y., to consider the electric railway project from Clyde to Sodus Bay has been held. At that time the highway commissioners signed the franchise offered by Mr. Charles A Lux, of Clyde.

Attorney A. M. Seymour has appeared before the board of supervisors, in Sacramento, Cal., and presented the petition of Mr. W. B. Bradford and others for a new road to connect the Wilder and the lower Stockton roads in Galt.

The Richmond Interurban Railway Company, Richmond, Va., has started work on its Centreville extension. Owing to the difficulty of getting material it will stop work for the present on the extensions to the Glenns and into Sevastopol.

Mr. John S. Rilling, of Erie, Pa., of the Erie & Conneaut Transit Company, has obtained from the Girard township road commissioners a franchise to build and operate

an electric road on Rice avenue between Girard and Miles Grove, Erie.

A new trolley line to connect with the New York & Queens County Electric Railroad at South street, and the Rockaway Road in Brooklyn, is being organized. Lawyer John A. Anderson, of Brooklyn, is preparing articles of incorporation.

The Baltimore, Westminster & Gettysburg Street Railway Company, of Baltimore, Md., which will open up a route 74 miles long from Gettysburg to Washington, has secured rights of way from nearly all the property holders along the route.

The Bloomsburg & Millville Electric Railroad, of Bloomsburg, Pa., has received the right of way through the streets of Millville from the borough council. This concession practically gives the company the right of way along its entire route.

The Indianapolis, Plainfield & Western Railway Company, of Indianapolis, Ind., has awarded the contract to an eastern firm for the construction of an electric line between Indianapolis and Plainfield, the work to be completed within eight months.

It is said that the electric railway between Iron Mountain and Vulcan, Mich., is now an assured fact. The company is composed of outside capital. Mr. G. W. Goodman, of Marinette, Wis., and Mr. Charles Goodman, of New York city, being at the head of the concern.

The city council of Benton Harbor, Mich., has granted franchises to the West Michigan Traction Company and the Benton Harbor Terminal Railway Company to construct, operate and maintain railways within the city limits. Work on both to be completed within one year.

At a meeting of the city council of Indianapolis City, Ind., the ordinance to grant a franchise to a company to build an electric line there was so amended that the company would not accept it and there will be no line constructed by the company which was desirous of securing a franchise.

The board of directors of the New Holland, Vandergrift & Leechburg Street Railway Company, of Leechburg, Pa., has decided to begin work immediately on the road. The power-house will be located at Leechburg and it is expected that the road will be in operation in about six months.

The board of directors of the New Orleans City Railroad Company agrees to accept the offer of Mr. H. H. Pearson, Jr., acting for Brown & Company, of Philadelphia, representing Philadelphia capitalists for the lease or purchase of their lines, 13 in number, and to recommend the stockholders to accept the offer.

A new electric tramway between St. Cloud and Suresnes, Puteaux, Courbevoie, Asnières, St. Denis and Pierrefitte has just been completed and opened for traffic. The line is 20 kilometres in length and is on the overhead conductor system. It is worked by La Compagnie des Tramways Mecaniques des Environs de Paris.

The Shickshinny & Huntington Valley Railroad Company has been formally organized at Shickshinny, Pa., and the charter for the same obtained from the state department at Harrisburg, Pa. The road is chartered from Shickshinny to Harveyville and is seven miles long. Mr. R. P. Robinson is its president.

Mayor Blushing, of Albany, N. Y., has signed the ordinance passed at a meeting of the common council which provides for the sale of a franchise for the construction, operation, etc., of an electric street railway on Delaware avenue at the intersection of Delaware and Madison avenues to the intersection of Delaware and Second avenues.

The North Texas Traction Company, which is building the interurban electric line to connect Ft. Worth and Dallas, Tex., has closed a contract for the erection of a power-house at Handley which is to cost $250,000. Fifty thousand dollars are to be expended in car sheds and despatchers' offices. Cars are expected to be running on this line within three or four months.

The Ossining Electric Railroad, of Ossining, N. Y., has been sold by receiver John B. Cockroft to Barrett & Henderson, Cleveland, Ohio, who represent a syndicate of bankers extensively interested in trolley enterprises. The road is to be extended at once to Pleasantville, Croton, Peekskill, White Plains, Portchester, N. Y., having its terminus at Kingsbridge. It is to be capitalized for $5,000,000 and equipped in the finest style.

The Delaware General Electric Company, of Dover, Del., which has undertaken to build 32 miles of trolley roads connecting the principal towns of Kent County and extending into Sussex, has held its annual meeting and reelected Mr. Leo. Belmont president. The company was organized in the summer of 1899, and it has taken nearly a year to secure the valuable rights of way over private property which it has now recorded.

The plans and specifications for the new power plant to be erected by the Amsterdam Street Railroad Company, of Amsterdam, N. Y., at the foot of Tribes Hill, have been received at the general offices of the company in Gloversville, and bids for the work have been opened. According to the estimates of Mr. C. H. Ledlie, of St. Louis, the company's electrical engineer, the plant will cost approximately $450,000. It will require a year for its construction.

The St. Louis, Clayton & Western Railway Company, of St. Louis, Mo., of which Mr. Lilburn G. McNair is president, has begun surveys for an electric railroad from the western part of Forest Park near the Clayton road to Clayton. A franchise was granted by the county court a year ago and work was to have been begun several months ago, but those interested concluded to wait until the location of the World's Fair site was announced. The road will run into the fair grounds.

Mr. Herbert W. Wolcott, general manager of the Kansas City & Leavenworth Railway Company, of Kansas City, Mo., has secured a charter at Topeka for the Missouri River Shore Line Railway Company with a capital stock of $50,000. This is the title of the new company which will construct the extension of the Kansas City & Leavenworth Electric Railway from its present terminus in Kansas City, Kan., to the state line, thence to connect with a proposed line to the business centre of Kansas City, Mo. Messrs. Herbert W. Wolcott, Leavenworth, Kan., and William P. Conlin, of Cleveland, Ohio, are among the incorporators.

The construction of the extension of the electric railroad from Johnstown, Pa., to New Amsterdam will not be commenced as soon as expected and hopes that cars would be running between the two cities this winter will not be fulfilled. The building of the line was postponed because the directors felt that it was best to order a new survey owing to the position of the Antlers Club, of Amsterdam, and the farmers residing near Tribes Hill. The farmers and the club demanded large prices for their land and in addition the Antlers Club engaged engineers and started a new survey through its property for the purpose of applying to the courts to have the company change its line through its property.

ELECTRIC LIGHTING

It is reported that the town of Slater, Mo., will soon have a new electric light plant.

The Oak Grove Electric Company, of Lock Haven, Pa., has been granted a charter. The capital stock is $1,000.

The United Electric Light and Power Company, of Baltimore, Md., is arranging to extend its lighting system.

The town of East Grand Forks, Minn., expects to have an electric lighting plant in operation in about six weeks.

The Electric Heat and Power Company, of Chicago, Ill., has changed its name to the Pearce Construction Company.

Until October 6 bids are asked for installing electric elevators in the government printing office at Washington, D. C.

The council of Jacksonville, Fla., has appropriated $27,500 to rebuild the electric lighting plant which was recently burned.

The city council of New Orleans, La., is investigating the feasibility of establishing a municipal electric lighting plant.

The building for the new electric light plant at Redfield, Minn., is about completed, and machinery will soon be placed in position.

Mr. T. C. Reed, of Chicago, Ill., has received the contract to build an electric light plant at Altamont, Ill., the cost not to exceed $12,875.

Director Immel, of the department of public works, Columbus, Ohio, states that work on the municipal electric light plant will be begun at once.

Messrs. Huehl & Schmidt have made plans for a new power-house for the Columbia Enameling and Stamping Company, at Terra Haute, Ind., which will cost $50,000.

A special meeting of the borough council of Media, Pa., is to be held for the purpose of receiving the revised bids for the installation of a municipal electric light plant.

A contract has been closed with the Goodman Manufacturing Company, of Chicago, Ill., for the construction of an electric light plant at the Prudence mines, on Loop Creek, W. Va.

Bids are asked until September 30 for installing electrical equipment of laboratories in various schools in the Borough of Brooklyn, N. Y., by the Board of Education, Park avenue and Fifty-ninth street.

The directors of the Sun Electric Supply Company, of Westchester, Pa., have decided to erect a one-story brick building. It will be detached so that danger of catching fire from the main building may be averted.

Proposals for an addition to a school building and electrical machinery are asked at the Department of the Interior, office of Indian affairs, Washington, D. C., until October 7, 1901, for a school building in Chillocco, Okla.

Mr. I. B. Roby, of Amherst, N. H., an electrical engineer in the employ of western capitalists, is in Topeka, Kan., looking over the electric light situation. The plan is to expend about $100,000 in the construction of an electric light plant in Topeka.

A permit for the addition to the Edison Electric Light Company's plant, St. Paul, Minn., has been issued. The building will be raised to a three-story structure. The building and the alteration will cost about $8,000, but nearly $100,000 will be spent before the plant is in operation.

ELECTRICAL SECURITIES

The faith of the people of this country in the stability of its institutions is well proved by the continued strength of the stock market after President McKinley's death. President Roosevelt's pledge, so promptly and impressively made, has apparently ended the awful shock brought to the business world by the assassin's bullet. As regards the general industrial field it should be remarked that the steel strike is over and labor difficulties generally have ceased, and the money situation at the present is satisfactory. Fall trade is very active, and the outlook for it to continue extremely good.

ELECTRICAL SECURITIES FOR WEEK ENDING SEPTEMBER 21.

New York:	Highest.	Lowest.	Closing.
Brooklyn R. T...	69½	65¼	69¼
Con. Gas.....	223½	219	223⅜
Gen. Elec.....	263⅞	259	263⅞
Man. El.....	123¼	116¼	122¾
Met. St. Ry.....	168½	162	168
Kings Co. Elec..	...	...	195
N.Y.&N.J.Tel.Co.	...	...	170
Telep.,Tel.&Cbl.Co.	...	...	5

The directors of the Metropolitan Street Railway Company have declared the usual quarterly dividend of 1¾ per cent.

There were important advances during the week just closed in Manhattan, Metropolitan and Brooklyn Rapid Transit. As these advanced simultaneously it was reported to be due to the suggestion of combination, although this rumor received but little attention. There was some talk of a decision on matters of taxation which will favorably effect all three of the companies.

The Westinghouse Electric and Manufacturing Company has declared a quarterly dividend of 1¾ per cent on its preferred stock, payable October 1. Books close September 21 and reopen October 2.

Boston, September 21:	Closing.
Am. Telep. & Tel.....	165
Erie Tel.....	42
New Eng. Tel.....	135
Mass. Elec. pf.....	91½
Westing. Mfg. pf.....	79
Edison Elec.....	250

The directors of the American Telephone and Telegraph Company have declared the regular quarterly dividend of 1½ per cent payable October 15 to stock of record September 30. Transfer books close October 1 to 14 inclusive.

It is announced here that the increase in gross earnings of the Erie Telephone Company thus far in 1901 equals that of last year and it is expected will show nearly a million gross over that of 1900. The regular quarterly meeting of the directors of this company is to be held this week to discuss a plan for permanently financing the company's obligations.

Philadelphia, September 21:	Closing.
Elec. Co. of America.....	7
Philadelphia Elec.....	5¼
Union Traction.....	28½
United G. I. Co.....	115
Elec. Stor. Bat. c.....	71
Elec. Stor. Bat. pf.....	78

The Electric Storage Battery Company has declared the regular quarterly dividends of 1¼ per cent on the preferred and 1¼ per cent on the common stocks, payable October 1. Books close from September 27 to October 1 inclusive.

Chicago, September 21:	Closing.
Chicago Edison Light.....	168
Central Union Telephone.....	45
Chicago Telep.....	265
Un. Trac.....	17⅜
Un. Trac. pf.....	58
Metropolitan El.....	92½

Offers from prospective bidders for the right to operate street railway lines throughout Chicago, Ill., are to be solicited by the council committee on local transportation. The intention is to secure a bidder to be given a franchise for the whole city.

TELEPHONE AND TELEGRAPH

The Standard Telephone Company has been granted a franchise by the city council of Burlington, N. J.

The Daniels Telephone Company, of Flora, Ill., is arranging for an extension of its lines to several towns near there. A double line will run from Xenia to Orchardville.

The People's Telephone Company, of Detroit, Mich., will soon absorb the Oakland Telephone Company, of Pontiac. Options on the majority of the stock were secured some time ago and it is stated it will be taken up before their expiration.

The Decatur County Independent Telephone Company, of Indiana, has increased its capital stock to $20,000, all of which has been paid in. The company now has over $150,000 of pole lines in the country, and is extending its line from Milhausen, New Point and Westport.

The Bell Telephone Company has begun the construction of its new line from Joplin Mo., southward. From Joplin the line will run due south to Racine, where one will be run to Neosho and another to Seneca. The latter line will be continued to Oklahoma City and Guthrie, while the Neosho line will be continued to Fort Smith.

The board of aldermen of Richmond, Va., has granted a franchise to the Southern Bell Telephone and Telegraph Company to do a local telephone business in that city for a term of 30 years. To the franchise were added two amendments, one limiting the rates to be charged by the company for the full term of the franchise rather than for 10 years only, and the other making it more specific and definite that no other city is to enjoy lower rates than Richmond.

The construction of the new telephone line from Newbern to Morehead City, N. C., has now reached a point five miles below Newbern. The system is being put up by the same parties which control the Henderson Telephone Company, which owns the system here as well as in other North Carolina towns. It is proposed to build an extension of the line from Morehead to Beaufort, a cable being laid across the mile-wide sheet of water that separates these places.

The Commercial Pacific Company has been incorporated at Albany, N. Y., for the purpose of laying a submarine cable from the Pacific coast to Hawaii, and thence to the Philippine Islands, making a direct cable route from the United States to the far east. The company will be affiliated with the Commercial Cable Company and its directors are: John W. Mackay, Clarence H. Mackay, George G. Ward, Edward C. Platt, Albert Beck, Albert B. Chandler, William W. Cook and George Clapperton.

The Western Union Telegraph Company recently issued a beautifully printed booklet entitled "A Retrospect." It is from the pen of Mr. A. R. Brewer, of that company, and is intended as an official sketch of the growth of the company during the 50 years of its existence to April 8, 1901. The articles of association of the New York & Mississippi Valley Printing Telegraph Company, the original name of the Western Union Telegraph Company, were filed at Albany in April, 1851. Mr. Brewer, who is the secretary of the company, has briefly yet interestingly and graphically presented this half-century history and the James Kempster Printing Company, of this city, has produced the book in a style of presswork and binding that reflects the highest credit. The sketch, which is abundantly illustrated, was issued only to the stockholders of the company.

PERSONAL MENTION

PROFESSOR F. C. VAN DYCK, who holds the chair of electricity and mechanics at Rutgers College, has been made dean of the faculty.

MR. CHESTER D. CRANDALL, of Chicago, manager of the Western Electric Company of that city, passed through New York recently returning with his family from an extended visit East.

MR. ALFRED BAKER, general manager of the Electric Traction System operated by the London County Council, and Electrical Engineer Rider, of the same British municipal body, are now in New York. They are particularly interested in the question of subways.

MR. GEORGE BULLOCK, president of the Bullock Manufacturing Company, of Cincinnati, Ohio, who has been in England for the last two months in connection with a proposition to build a plant there for the purpose of manufacturing apparatus for the British and other European markets, has returned to the United States.

MR. HENRY L. SHIPPY, treasurer of the John A. Roebling's Sons Company of New York, is receiving the congratulations of his many friends in electrical circles over his escape from his yacht, the Rapidan, which ran aground off Cape Henlopen. Mr. Shippy and Mr. Karl G. Roebling were on board and they, with the entire crew, were taken ashore in boats but the yacht was a complete loss. The disaster happened in the early evening of September 10, during a severe storm.

AUTOMOBILE NOTES

A handsome electric automobile has arrived in Oakdale, Long Island, for Mr. W. K. Vanderbilt. The machine is to be operated upon the roads about Idle Hour, at a moderate rate of speed, in order to get its machinery in good running order before Mr. Vanderbilt returns from Europe.

An automobile for fire departments has been built by the Eagle Velocipede Works, of Frankfort, Germany. It is to be exhibited at the Berlin Exposition for Fire Extinguishing and Life-Saving Apparatus. Four men are carried by the automobile, which has a speed of about 11 miles an hour. It will be used to render first aid in case of fires.

In the neighborhood of Vienna, Payerbach and Reichenau, Austria, a public automobile service has been inaugurated recently between the two towns. The vehicles are of the large omnibus pattern, and the electric system is used. They make good time and are very comfortably arranged. They were built by Jacob Lohner & Company. It is said that the system has already met with great favor by the inhabitants, and especially with the foreigners who pass the summer at Reichenau, a watering place of some importance.

The Rhode Island Automobile Club is advocating a uniform state law for restricting the speed of automobiles in the cities and towns to eight miles an hour and in the country to 15 miles in view of the increasing number of conflicting local speed ordinances in Rhode Island. An enactment covering the above and having also a clause providing that any bicyclist or horse driver may signal automobilists to stop will be presented by the club at the next meeting of the legislature. By the only speed law on the books it is provided for a fine of not less than $5 and not more than $20 for riding or driving faster than a traveling pace in any city or town of the state or on any road leading from Pawtucket to the back part of Providence.

INDUSTRIAL ITEMS

THE McGUIRE MANUFACTURING COMPANY, of Chicago, Ill., has received orders for 130 trucks, which are to be shipped for utilization by English electric traction systems.

THE BRITISH THOMSON-HOUSTON COMPANY has recently secured some important contracts for various electrical apparatus to be installed in the works of the Walker & Wallsend Union Gas Company, and the Newcastle Electric Supply Company.

THE ELECTRIC APPLIANCE COMPANY, of Chicago, Ill., has just placed upon the market a new cabinet type dry battery wall telephone, No. 36. Descriptive matter will be sent upon application to those who have been missed in the distribution.

THE BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, LIMITED, is reported to have placed a large order for turret lathes with Albert Herbert, Limited, of Coventry, England. The lathes are to be installed in the Manchester plant of the British company.

CHIEF ENGINEER PEASE, of the Buenos Aires & Rosario Railway, is now in the United States for the purpose of placing contracts for quantities of machine tools and electrical equipment to be installed in the workshops of that railway. It is said that his purchase will represent an aggregate expenditure of nearly $250,000.

MR. HERBERT O. WARNER, of Hartford, Ct., is issuing an attractive illustrative booklet, entitled "Trips by Trolley Around Hartford." It will be found of great interest to many as long-distance trolley riding is becoming more popular every day. The territory from New York to Boston is covered pretty thoroughly in this booklet. The sale has been large, and three editions have already been printed.

THE OTIS ELEVATOR COMPANY, of New York, is making shipments of electric passenger and freight elevators, particularly to Great Britain and Germany. Some shipments are also being made to Belgium, Spain, Hungary and South America. The Otis company has just secured, through its London interests, a contract calling for the installation of electric elevators in Buckingham Palace, London.

THE INTERNATIONAL SPECIALTY COMPANY, Chicago, Ill., is receiving very large orders for its No. 1 telephone, and is having all it can do to supply the demand. In the future it is planned to manufacture a complete line of exchange, toll line and intercommunicating private line and desk telephones, but up to this time, owing to the demand for the No. 1 telephone, it has not had an opportunity to put these on the market.

THE BILLINGS & SPENCER COMPANY, Hartford, Ct., is manufacturing a machined steering equipment for automobile service. The bearings are fitted with hardened and ground tool steel cups and cones and have a positive adjustment that can be worked by removing the dust cap. The tubs are drilled for either straight or tangent spokes, and are fitted with felt and leather washers, also dust caps. This steering equipment is suitable for carriages weighing up to 1,600 pounds, without passengers.

UNITED STATES CONSUL J. M. RUFFIN, at Asuncion, Paraguay, who is now spending his leave of absence in the United States, is reported to have brought with him a number of important orders from the Paraguayan Government. Among others a large order has been placed with the American Steel and Wire Company for steel and wire and the Western Electric Company for telegraphic appliances to the amount of $7,000 for a new telegraphic line from Asuncion to several important ports on the Bolivian frontier.

THE BRITISH ELECTRIC TRACTION COMPANY, in which Mr. J. P. Morgan, through J. S. Morgan & Company, of London, is largely interested, has invited figures for the supply of 5,000 tons of steel-grooved girder tramway rails, fish-plates, etc. It is understood that the Lorain Steel Company is figuring on the contract. The British company is engaged very extensively in the construction of electric traction systems in England, having recently obtained a number of contracts in the midland and northern districts, and in connection therewith the letting of a number of valuable contracts for equipment, machinery, etc., will be determined on shortly. The offices of the company are at Donington House, Norfolk street, Strand, London, W. C.

THE INCANDESCENT ELECTRIC LIGHT AND MANIPULATOR COMPANY, of Boston, Mass., manufactures the incandescent electric lamp replacers and cleaners with which the incandescent lamps when burned out are replaced at the Pan-American Exposition, where they are located in high and difficult places to get at. These machines are said to be so designed and put together that they will unscrew or screw in any shape or size of incandescent lamp at any height or angle. Being made of aluminum they are very light in weight and after a little practice are very easy to handle, and by them the use of long extension step-ladders is done away with. These machines are made in several different styles and are used all over the world.

THE J. G. BRILL COMPANY, of Philadelphia, Pa., builders of electric cars, will soon establish a plant in England. Mr. John A. Brill, vice-president of the Brill Company, is now in England for the purpose of selecting a location for the new works. Three places are under consideration, Preston, in Lancashire, the Midlands, near Birmingham, and a place in the vicinity of London. Mr. G. Martin Brill, president of the Brill Company, says: "It is only within a few days that we definitely decided to build. When Mr. Brill returns from England in about two weeks' time, details will be settled so as to enable us to start the construction of the works almost immediately. It is our intention to devote ourselves exclusively to the manufacture of trucks for the British market. The equipment will be of American make." There is no more widely and favorably known manufacturing company in this line in the United States.

THE HAZARD MANUFACTURING COMPANY, of Wilkesbarre, Pa., is issuing some very attractive booklets describing the merits of its wire rope of steel and iron for shafts, slopes, quarries, elevators, ferries, suspension bridges, ships and yachts' rigging, dredges and derricks, transmission of power, tramways, underground and surface haulage and cable railways. These ropes are said by the manufacturer to be made of the best brands of Swedes charcoal iron, English crucible cast steel and plough steel wire. All sizes and kinds of the wire mentioned above are constantly kept on hand in the warehouses in Wilkesbarre, New York and Chicago. This company is also issuing a booklet describing its Pan-American insulated wire. It now manufactures bare copper wire, insulated wires and cables, the works having been recently extended to manufacture these supplies. This new department is equipped with the most modern and improved facilities for the production of insulated wires and cables of the highest grade. The range of manufacture covers weather-proof and rubber-covered wires and cables, magnet wire of all shapes, cotton and silk-covered and special conductors to meet the requirements of the best electrical engineering practice.

NEW INCORPORATIONS

ROSSVILLE, IND.—Home Telephone Company. $2,500.

PAOLA, KAN.—Franklin Light and Fuel Company. $200,000.

OAK GROVE, PA.—The Oak Grove Electric Company. $1,000.

DOVER, DEL.—Washington Water, Light, Heat and Power Company of Ohio. $500,000.

GOSHEN, IND.—Goshen Southern Traction Company. Incorporators: M. L. Latta, L. W. Vail and others.

DOVER, N. H.—Dover & Elliott Street Railway. $25,000. To construct an electric railway from Dover to Elliott.

KANSAS CITY, MO.—Winfield Telephone Company. $25,000. Incorporators: L. P. Smith, R. B. Montague and others.

WHEELING, IND.—Wheeling Telephone Company. $1,500. Directors: Elmer E. Goone, I. Newton Brown and others.

DES MOINES, IOWA—Southern Iowa Telephone Company. $60,000. Directors: D. M. Smith, L. M. Grimes and others.

PEORIA, ILL.—The Peoria Belt Line Railway Company. $100,000. Incorporators: Theodore J. Miller, W. T. Irwin and others.

MANGUM, OKLA.—The Mangum Electric Light and Ice Company. $160,000. Incorporators: M. Mathews, J. R. Lane and others.

COOPER, MO.—The Cooper Light and Manufacturing Company. $20,000. Incorporators: W. H. Jones, R. C. Combs and others.

ROSSVILLE, IND.—Rossville Home Telephone Company. $2,500. Incorporators: William W. Rose, John Fisher and others.

NORTH MANCHESTER, IND.—The Eel River Telephone Company. $10,000. Directors: Benjamin Oppenheim, Lewis Signs and others.

CINCINNATI, OHIO—The Cincinnati Telephone Company. $10,000. Incorporators: Peter Nodler, Joseph H. Becker and others.

CHICAGO, ILL.—Austin Yarian Company. $2,500. Water, light, heat and power plant. Incorporators: H. M. Wisler, W. O. Merrick and others.

WOODSTOCK, ILL.—Woodstock Exchange and Telephone Company. $20,000. Incorporators: Charles H. Donnelly, George W. Field and others.

DETROIT, MICH.—The Detroit, Pontiac, Lapeer & Northern Electric Railway Company. $1,000,000. Incorporators: James Dean, Orrin J. Price and others.

ANNA, ILL.—Southern Union Telephone Company. $10,000. To incorporate a telephone, telegraph and electric light system. Incorporators: Thomas N. Perrine, F. W. Willard and others.

CANASTOTA, N. Y.—The Oneida Traction Company. $500,000. To operate a street surface electric road 10 miles long from Canastota to Sherrill, Oneida County. Directors: Harry C. Stone, E. L. Hunt and others.

INDIANOLA, OHIO—Indianola Heating and Lighting Company. To supply Indianola with electric power, light and heat, and also steam heating and hot water through a system of pipes. Incorporators: William H. Sharp, C. E. Richards and others.

LA PORTE, IND.—La Porte County Electric Company. $160,000. To own, maintain and operate machinery for the manufacture of light, power and heat and to sell the same in the cities of La Porte and Michigan City and in La Porte County. Directors: W. A. Boland, of New York; D. F. Lewis, of New York, and others.

List of Electrical Patents Issued Last Week

[Specially reported for this journal by E. S. Duvall, solicitor of patents, Loan and Trust Building, Washington, D. C. Copies of any patent may be secured for 10 cents each.]

ISSUED SEPTEMBER 17.

682,618 Electrical starting and regulating switch; A. H. Hickley, Rock Ferry, England.

682,642 Means for controlling electric motor vehicles; J. Sachs, Hartford, Ct.—A source of electric energy and the actuating motor, devices for automatically varying the field strength of the motor whereby, without an increased current supply from the source of electric energy, an additional torque demanded of the motor is delivered at a decreased speed, and *vice versa*.

682,646 Dry battery; H. Splitdorf, New York, N. Y.

682,661 Electrical thermostat; T J. Zoeller, Nashville, Tenn.

682,678 Electric clock; R J. Flint, Decatur, Ill. Consists of a pendulum, a horizontal impulse-weight at one end, a spring-detent on the swinging end of the impulse-weight, a fixed stop to engage the detent and hold the weight raised, and an impact-arm on the pendulum that forces the spring-detent clear of the stop and receives the impulse-weight.

682,690 Electric lamp; P. C. Hewitt, New York, N. Y.—A gas or vapor lamp, consisting of a conducting vapor or gas, constituting the sole path for the current while the lamp is in operation, a starting material serving to permit the initial passage of the electric current through the lamp.

682,691 Method of operating electric lamps; P. C. Hewitt, New York, N. Y.

682,692 Method of manufacturing electric lamps; P. C. Hewitt, New York, N. Y.

682,693 Starting apparatus and circuit for electric lamps; P. C. Hewitt, New York, N. Y.

682,694 Electric gas or vapor lamp and electrode therefor; P. C. Hewitt, New York, N. Y.—A closed chamber, a gas of such density as to convey currents of considerable quantity under moderate pressures, an electrode, and a protecting-sleeve of non-conducting material.

682,695 Method of controlling gas or vapor electric lamps; P. C. Hewitt, New York, N Y.

682,696 Method of producing light by electricity; P. C. Hewitt, New York, N. Y.

682,697 Apparatus for producing electric light; P. C. Hewitt, New York, N Y.

682,698 Enclosing case for electric lamps; P C. Hewitt, New York, N.Y.

682,699 Method of manufacturing vapor or gas lamps; P. C. Hewitt, New York, N. Y.

682,705 Contact device for conduit electric railways; W. F. Jenkins, Richmond, Va.—A trailing contact for a conduit electric railway, the combination of a plow connected to the car and depending through the conduit slot in the conduit, and provided with a link pivoted to its lower end within the conduit, a shoe-supporting block pivoted to the lower end of the link, and having pivoted to it one or more contact-shoes which rest and slide upon the line conductors within the conduit, and are by suitable electrical conductors connected to the motors.

(*Continued on page 33.*)

PATENTS.

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NOTICE is hereby given that the annual meeting of the Stockholders of the Electrical Review Publishing Company, for the election of Board of Directors for the ensuing year, and the transaction of such other business as may properly come before the meeting, will be held at the offices of the company, Nos. 13-21 Park row, in the City of New York, on the 12th day of October, 1901. The polls will be opened at three o'clock and closed at four o'clock, P M.

STEPHEN H. GODDARD,
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September 23, 1901.

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PATENTS.

(Continued from page 31.)

682,706–707 Contact device for conduit electric railways; W. F. Jenkins, Richmond, Va.

682,708 Suspensory device for trailing contacts for conduit electric railways; W. F. Jenkins, Richmond, Va.

682,709 Insulator; W. F. Jenkins, Richmond, Va.

682,710 Bond for electric railway conductors; W. F. Jenkins, Richmond, Va.—A detachable bond for tubular conductors, consisting of a support adapted to receive and support the adjacent ends of two conductor lengths and perforated to admit the passage of a bolt, and a nut or clamping bar located inside of the tubular conductors and into which the bolt is threaded and screwed.

682,711 Conduit for electric railways; W. F. Jenkins, Richmond, Va.

682,714 Means for protecting circuits; J. F. Kelly, Pittsfield, Mass.—A system of distribution by alternating currents, comprising a main conductor, two branches between said main conductor and the earth, possessing capacity and self induction respectively, and tuned to the normal frequency of the circuit.

682,729 Electric switch; H. A. Metz, Brooklyn, N. Y.

682,732 Supervisory signal for telephone systems; F. R. McBerty, Downers Grove, Ill.

682,742 Portable electric lamp; H. E. Plass, New York, N. Y.

682,796 Electromagnetically operated door-opener; J. M. G. Gould, Boston, Mass.

682,818 Switch for electromotors; R. A. Sloan, Liverpool, England.—The switch-bar, the contacts, the spring carried in one of the contacts, the detent, and the means for releasing the detent.

682,828 Electro-pneumatic controlling system; E. R. Hill, Wilkinsburg, Pa.

682,831 Adjustable insulator; H. D. Murdock, Pittsburgh, Pa.

682,845 Electric cable for three-phase alternating currents; W. B. Essen, London, England—Consists of three principal conductors and a fourth or neutral conductor, divided into a series of separate wires arranged between the principal conductors and insulated therefrom

682,856 Sparking igniter for explosive engines; W. C. Matthias, Reading, Pa.

682,893 Conductor; F. Tremain, Highgate, England.

682,898 Dynamo-electric machine; C. De Witt Anderson, Chicago, Ill.—A hub-motor, comprising an axle and a wheel having a hub journaled upon the axle, a motor having a casing surrounding and journaled upon the axle, the outer end of the casing being attached to the wheel.

682,899 Accumulator plate; H. T. d'Arnault, Paris, France.

682,919 Electric fuse; L. W. Downes, Providence, R. I.

682,942 Rotary transformer; B. G. Lamme, Pittsburgh, Pa.

682,943 Method of changing frequency of alternating currents; B. G. Lamme, Pittsburgh, Pa.

682,949 Electric heater; J. F. McElroy, Albany, N. Y.

682,971 Electrostatic measuring instrument; J. H. Bryson, St. Louis, Mo.

682,974 Wireless telegraphy; H. P. Davis, West Philadelphia, Pa.—A receiving station comprising a tube, metallic particles located therein, a circuit through the particles, a relay actuated by the circuit, and two electromagnets actuated, one at a time, to give said tube a horizontal movement, or to reciprocate the same to disturb the particles.

682,978 System of electrically lighting railway carriages; E. Dick, Baden, Austria.

682,996 Electrode; J. K. Pumpelly, Chicago, Ill.

683,000 Method of obtaining aluminum-hydrate by electrolysis; I. L. Roberts, New York, N. Y.

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Sealed proposals will be received here until noon, October 16, 1901, and then publicly opened, for furnishing and installing Electric Elevators for New Building for Government Printing Office. Information furnished on application.
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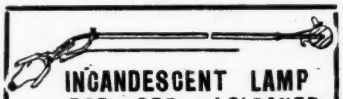
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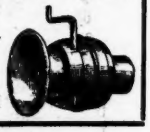
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